

Graduate Schools Course Descriptions

Northeastern University
1985—86

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Northeastern University

1985–1986

Graduate Schools

Course Descriptions

Arts and Sciences

Business Administration

Boston-Bouvé College

of Human Development Professions

Professional Accounting

Computer Science

Criminal Justice

Engineering

Pharmacy and Allied Health Professions

Northeastern University charges tuition for all courses taken above the normal academic load.

The University reserves the right to make changes in the regulations and courses announced in this bulletin.

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Northeastern University is committed to a policy of equal opportunity for all students and employees without regard to race, color, religion, sex, sexual preference, national origin, or handicap or veteran status. The University prohibits discrimination in all matters involving admission, registration, and all official relationships with students, including evaluation of academic performance.

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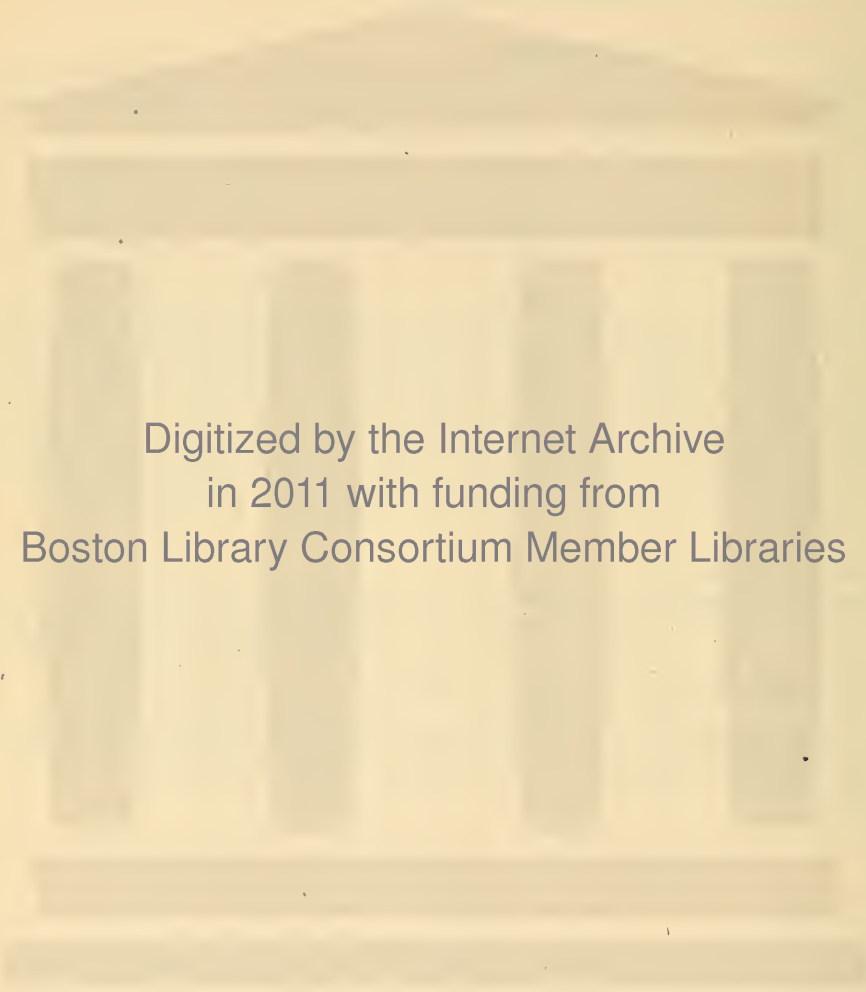
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Inquiries concerning our equal opportunity policies may be referred to the University Title IX Coordinator/Compliance Officer for Section 504 of the Rehabilitation Act of 1973, Affirmative Action Office, Richards Hall. Telephone: 617-437-2133.

Accreditation Statement

Northeastern University is accredited by the New England Association of Schools and Colleges, Inc., which accredits schools and colleges in the six New England states. Accreditation by the Association indicates that the institution has been carefully evaluated and found to meet standards agreed upon by qualified educators.

Tuition rates, all fees, rules and regulations, courses and course content are subject to revision by the President and the Board of Trustees at any time.



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The following is a list of courses offered by the graduate schools of Arts and Sciences, Boston-Bouvé College of Human Development Professions, Business Administration, Criminal Justice, Computer Science, Engineering, Pharmacy and Allied Health Professions, and Professional Accounting for the academic year 1985-1986.

To obtain course listings for the school of Law, please refer to the catalogue.

In order to register for courses outside one's graduate school, students *must* meet the requirements of the school offering the course(s) as well as their home school.

Students may not register for any courses outside their school unless the appropriate permit is presented at registration. Consult your graduate school office for details concerning these procedures.

Arts and Sciences

Graduate School of Arts and Sciences

Anthropology and Sociology

All courses carry three quarter-hours of credit unless otherwise specified.

Social Anthropology

Many undergraduate courses in the SOA 300 and 400 series may be offered for graduate credit. Students should check the current course announcements to take advantage of these offerings.

SOA 3100 Theory 4 Q.H.

History of major contemporary orientations: evolutionary approaches, culture area, cultural ecology, functionalism, structuralism, and analysis of current status of these and related theories.

SOA 3101 Human Origins 4 Q.H.

An examination of the data on fossil remains and on contemporary primates which are essential for understanding human physical and behavioral evolution.

SOA 3102 Evolution of Society 4 Q.H.

The development of political and economic institutions beginning with foraging societies and the sexual division of labor: specialization, social stratification and the emergence of civilization.

SOA 3120 Visual Anthropology

Explores the anthropologist's use of film to gather information and analyze cultural subsystems. In addition to reading about and viewing films on particular populations, students are introduced to the field through a laboratory aspect of the course involving the use of tape and video equipment.

SOA 3121, SOA 3122 Fieldwork I, II 4 Q.H. each

Data collection through participant observation and related anthropological methods. Data analysis and reports. (Not offered in years in which SOC 3120 and SOC 3121 are offered.)

SOA 3135 Language and Communication

Human communication, including language. Theories of the evolution of language and the application of models derived from the study of language to other aspects of behavior.

SOA 3145 Peasants

Institutions of peasant society. The structure of traditional civilizations and the interrelations between urban and local communities: comparative and functional analysis of the peasant community and the dynamics of change from peasant to postpeasant and industrialized societies.

SOA 3155 Individual and Culture

Examination of current theory and method in the study of the interplay between personality and culture. Contributions by various disciplines are discussed.

SOA 3156 Family in Evolutionary Perspective 4 Q.H.

The emergence of family from prehuman patterns, its biological and behavioral components, and its cross-cultural variations examined from an evolutionary perspective.

SOA 3185 Aggression

Concepts of aggression as they have been used in evolutionary and comparative anthropological formulations. Professional and popular publications in anthropology, ethology, and psychology are analyzed.

SOA 3220 Culture and Mental Illness

Discussions and analyses of the nature and meaning of culture, the role of culture in personality formation, culture and anxiety, anthropological approaches to the normal and the "abnormal," and the question, "Is mental illness psychological fact or cultural fiction?"

SOA 3265 Anthropology of Religion

Nature and institutionalization of primitive, ancient, and contemporary religions. Exploration of religious concepts and movements in relation to social, religious, and political organization.

SOA 3275 The Anthropology of Music

The examination of music in a prehistoric and cross-cultural perspective, with emphasis on ethnomusicology and the comparison of Western and non-Western musical culture. Functions and social contexts of musical composition and performance; the ethnography of musical performance groups, the analysis of music as a form of communication.

SOA 3300 Cultural Ecology

Examines human adaptation to environment and the effect of different human adaptations on natural systems.

SOA 3310 Social Change and Economic Development

Selected studies of processes of transformation and modernization in nonindustrial societies.

SOA 3345 Urban Ethnography

Selected problems in anthropological studies in urban societies.

SOA 3355 The Anthropology of Law and Conflict

Settling disputes in stateless societies; forms and mechanisms of social control; law as an indicator of cultural and social norms; the study of conflict resolution as an ethnographic tool. Some field research and analysis is required.

SOA 3360 Economic Anthropology

Types of economic systems in simple societies: reciprocal, redistributive, market exchange; economic relations as part of social relations; land-tenure systems, credit systems, savings mechanisms. The transition from subsistence to cash economics.

SOA 3410, SOA 3411, SOA 3412, 3 Q.H. each

SOA 3413 Contemporary Issues in Social Anthropology

Contemporary issues in the field of anthropology. Supervised readings and written reports on special programs.

SOA 3420 Kinship and Social Structure

A variety of kinship systems and their terminological and structural components and the way in which their systems articulate with other social institutions.

SOA 3425 Tribal Societies and Culture

The structures and institutions of bands, tribes, and chiefdoms: comparative and functional studies of tribal societies and the dynamics of change under contact situations.

SOA 3440, SOA 3441, SOA 3442, 3 Q.H. each SOA 3443, SOA 3444, SOA 3445

Ethnographic area courses (New World Indian, African, Indian, Chinese, and others) are offered as resources permit.

SOA 3600, SOA 3601, SOA 3602 3 Q.H. each Seminar

Discussion of selected topics in the field of anthropology.

SOA 3798 Master's Thesis Continuation 0 Q.H.

SOA 3800, SOA 3801, SOA 3802 Directed Study in Social Anthropology Maximum: 9 Q.H.

Reading and empirical research in social and cultural anthropology supervised by members of the anthropological staff.

SOA 3810 Master's Paper in Social Anthropology 6 Q.H.

Empirical or library research meeting the criteria for publication in a professional journal. *Supervision by members of the department.*

Sociology

Many undergraduate courses in the SOC 300 and 400 series may be offered for graduate credit. Students should check the current course announcements to take advantage of these offerings.

SOC 3100 Foundations of Social Theory I 4 Q.H.

The classic theorists (Durkheim, Weber, Marx, Simmel, and others) are considered intensively.

SOC 3101 Foundations of Social Theory II 4 Q.H.

An intensive analysis of modern theorists from the 1930s onward (Parsons, Merton, Levi-Strauss, Goffman, Homans, Schutz, Garfinkel, Ricoeur, Lukacs, Habermas, and others). The social and historical context of theory construction is stressed.

SOC 3103 American Society

Study of the development of, and the changes in, the institutional structure of American society in comparison with certain other social systems.

SOC 3113 Introduction to Research Methods 2 Q.H.

An introduction to methods of social research including field study and participant observation techniques, survey techniques, interviewing and questionnaire construction, sampling procedures, experimental design, content analysis, and uses of available data. *Open only to law, policy and society students.*

SOC 3114 Introduction to Quantitative Research Methods 2 Q.H.

An introduction to quantitative techniques of analysis. Students are expected to conduct individual research projects. *Open only to law, policy and society students. Prereq.: SOC 3113 or equivalent.*

SOC 3115 Statistical Methods for Sociologists 4 Q.H.

Detailed introduction to statistical methods relevant to sociology. Topics include tabular analysis, non-parametric statistics, analysis of variance, regression analysis, path analysis, measures of association, estimation and univariate and multivariate hypothesis testing. A knowledge of elementary statistical theory is presumed.

SOC 3116 Introduction to Research Methods 4 Q.H.

A survey of methods of social research including field study and participant observation techniques, survey techniques, interviewing and questionnaire construction, sampling procedures, experimental design, content analysis, and use of available data.

SOC 3117 Quantitative Research Methods

Quantitative techniques of analysis. Students are expected to conduct individual research projects. *Prep.: SOC 3116 (or equivalent) or consent of the instructor.*

SOC 3120, SOC 3121 Seminar in Qualitative Analysis I, II 4 Q.H. each

Qualitative techniques of analysis. Social-structure process and meaning in interacting groups. Each student is expected to study a face-to-face group by means of participant observation using symbolic interaction concepts. *(Not offered in years in which SOA 3121 and SOA 3122 are offered.)*

SOC 3125, SOC 3126, SOC 3127 1 Q.H. each Proseminar

This course is suggested for entering students. The focus is on issues related to graduate student life and expectations, professional and career choices, and works in progress. Students have an opportunity to explore more informally, with each other and with various faculty members, some of the important issues in the profession.

SOC 3135 Issues in Social Psychology

Human behavior and theories of self from a sociological and psychological perspective. Special consideration of interpersonal relations, socialization, and symbolic interaction.

SOC 3140 Sociology of Prejudice and Discrimination

A study of the characteristics, causes, and consequences of prejudice and discrimination, with particular reference to American society.

SOC 3147 Urban Sociology

Theories of the development of urban life. Comparisons between preindustrial and industrialized urban areas. Methods for the study of urban social structure and change. Evaluation of contemporary metropolitan action programs.

SOC 3148 Boston Seminar

A case study in urban development, including the evaluation of environmental and historical circumstances, demands for services, response to events, programs. Basis for value systems of Yankees, ethnics, and cosmopolitans. Impact on downtown and neighborhood relations. Metropolitan prospects.

SOC 3149 Metropolitan and Regional Issues

Comparative analyses of problems, policies, programs, and activities associated with metropolitan and regional life. Includes assessment of values, institutions, networks, interest groups, decision making, service delivery, growth and development, environment, equity, and integration. Case studies in societal context.

SOC 3155 The Family

Social structure and social functions of the family as a social institution. Relations between the family and other institutions in society are examined comparatively and historically.

SOC 3160 Women, Men, and Social Change

The Industrial Revolution and the corresponding changes in the labor force and patterns of domestic life have altered the sexual division of labor. In post-industrial society new institutional forms are recasting personal relations. The course examines these forces of social change and their impact on sex roles.

SOC 3165 Sociology of Education

The structure and functioning of educational institutions. Student, faculty, and administrative perspectives. Emphasis is placed on the role of education in processes of socialization, social mobility, social change, and social control.

SOC 3166 Sociology and Anthropology in 4 Q.H. the Schools

(Listed as ED 3322 in the Boston Bouvé Graduate School catalog) The course offers a setting in which current and prospective teachers of sociology and anthropology at the precollege and community college levels have the opportunity to analyze curricula in their fields and consider alternative rationales for various approaches to teaching sociology and an-

thropology at these levels. Study also focuses on the potential uses of sociological and anthropological concepts in analyzing and solving educational problems. Students are expected to present either a course or unit they have prepared or a project they have planned or conducted utilizing a sociological or anthropological perspective.

SOC 3170 Intergroup Relations

The relations between various racial, national, cultural, and religious groups with emphasis on historical development. Particular attention is paid to American society with its specific problems of adjustment and assimilation.

SOC 3171 Race and Ethnic Relations: A World Perspective

Cross-cultural analysis of race and ethnic relations in Western and non-Western societies. Explanations of race and ethnic relations in terms of contemporary developments, world problems, and ideological conflicts.

SOC 3175 Sociology of Work

The course is designed to examine the effects which the social organization of work has on the lives of workers as well as on the structure of society.

SOC 3176 Sociology of Occupations and Professions

The relations between the occupations and professions and society. Special topics may include occupational stratification, professional group behavior, recruitment and socialization of occupations and professions, and political activism.

SOC 3185 Sociology of Deviant Behavior

Applications of sociological concepts and principles to some problems of social disorganization in industrial societies. Analysis of such problems as suicide, prostitution, physical handicaps, unemployment, alcoholism, sexual deviance, and gambling.

SOC 3186, SOC 3187 Social Control I, II

Seminar in research, theories, and methods in the sociology of social control.

SOC 3190 Sociology of Delinquency

Social and social psychological factors of delinquency and their implications for prevention, rehabilitation, and treatment.

SOC 3200 Sociology of Alcoholism

The course examines four general problem areas: the conditions under which people categorize others as alcoholics; the processes by which persons so defined are assigned deviant status and assume appropriate roles and self-images as alcoholics; the development of drinking careers and their relationship to deviant subcultures; and the social situations in which people transform their deviant identities as alcoholics. The course applies organizational analysis to the development and changing network of alcoholism treatment services and tries to develop some tentative generalizations on the social organization of alcoholism.

SOC 3205 Sociology of Crime and Justice

A sociological and legal analysis of the criminal justice system, concentrating on police and law enforcement; plea-bargaining; courtroom research and trial strategies; sentencing; and prisoners' rights and corrections. The relationship between race, social class, and crime is also considered, as are the sociological explanations of crime causation.

SOC 3206 Sociology of Law

Fundamentals of law. The concept of social control. Order and law. Consensus and conflict. Analysis of the normative-formative influences of law. Mores and morals. The concept of justice. Analysis of some legal institutions.

SOC 3215 Sociology of Medicine

Social aspects of illness and medicine, historically and cross-culturally. Illness and the medical profession in modern society and their structural settings: the community, the hospital, the medical school. Research studies in the field are examined critically and problems for future research specified.

SOC 3225 Sociology of Aging

A critical examination of the field of social gerontology, the nature and roots of ageism and topics such as elderly housing, life study, institutionalization, health care, retirement, leisure, and senior power.

SOC 3226 Processes of Aging

Socioeconomic and social psychological consequences of aging are examined from the perspective of health-care providers. A major part of the course focuses directly on the biological changes entailed in aging and the appropriate medical management of geriatric patients. Open to students expected to provide health-care services to geriatric patients.

SOC 3240 Formal Organizations:

Administration and Structure

Analysis of the goals and functions of modern organizations. Aspects of bureaucratization are examined within business firms, public institutions, and private associations.

SOC 3245 Sociology of Poverty

An analysis of sociological perspectives on causes of poverty, public views on poverty, and institutional responses to poverty. A concern with policy issues and implementation of policies is emphasized. For advanced students in the social sciences and in the various human service schools in the University.

SOC 3275 Sociology of Art

Examination of the practices which lead to the production of artistic meaning; the relationship of art to society; the nature of artistic communities, their relationship to patronage systems and art markets; the manner in which these systems are rooted in particular social and historical contexts.

SOC 3276 Popular Culture

Both pluralist and mass culture theories are inadequate in explaining mass popular culture; therefore, a primary objective of the course is to develop and

refine an efficient theoretical framework. Problems to be addressed include the relationship between popular culture, high culture, and folk culture and the genesis and role of the mass media in industrial societies. The course also focuses on empirical research in several forms of popular culture, including sports, rock music, and science fiction novels. Organization and impact of market, stylistic shifts, and the viability of criticism are examined.

SOC 3286 The Sociology of Science

Selected topics dealing with interactions between science and society.

SOC 3300 Contemporary Sociological

Theories Analytic treatment of major contemporary theories such as functionalism, conflict, neo-Marxism, and others. *Prep.: SOC 3100 and SOC 3101 (or equivalent) or consent of the instructor.*

SOC 3301 Recent Developments in Sociological Theory

New horizons in theory and the relation of theory to research. Topics to be selected and announced by the instructor. *Prep.: SOC 3100 and SOC 3101 (or equivalent) or consent of the instructor.*

SOC 3302 Sociology of Knowledge

The relationship between the social base of a society and its intellectual products. The viewpoints of authors such as Marx, Weber, Mannheim, G.H. Mead, the Neo-Marxians, and other modern schools are considered. *Prep.: SOC 3100 and SOC 3101 (or equivalent), or consent of the instructor.*

SOC 3303 Economic Sociology

The role of economic factors in the social process. Consideration is given to both classic economic theory and its impact on classic social theory, and the potential interrelations between modern economic theory (especially model-building approaches) and general sociological problems.

SOC 3304 Feminist Theory

Considers major trends in feminist theory since the rise of the contemporary women's movement. It begins with early theories, identified as Marxist-Feminist, Socialist-Feminist, and Radical-Feminist, and then considers important feminist issues: the origins and universality of women's oppression, the reproduction of gender in the family (neo-Freudian feminist and anthropological approaches), women's work under capitalism, and sexuality.

SOC 3310, SOA 3311 Social and Cultural Change S,A

Two-quarter course in conjunction with Anthropology. Analysis of the changing patterns in social, economic, and political institutions. Modern social trends are discussed.

SOC 3320 Multiple Regression in Sociological Analysis

This course focuses on techniques of sociological analysis based on multiple regression, e.g., use of coded variables, trend analysis, covariance analysis,

model testing. *Prep.: SOC 3117 and SOC 3115 (or equivalents).*

SOC 3321 Current Issues in Social Research

Selected topics in methods of social research are examined. *Prep.: SOC 3116 and SOC 3117 (or equivalent) or consent of the instructor.*

SOC 3322, SOC 3323 Experimental Methods in Social Research I, II

Experimental design and laboratory methods in sociology. The small groups laboratory is treated as a setting for testing sociological theory. The emphasis is upon techniques and problems in the creation and manipulation of social variables in the laboratory situation, although the techniques of the natural experiment are also considered.

SOC 3325 Sociology of Policy, Planning, and Evaluation

A general introduction to the social, political, and economic factors affecting policy formation and the eventual success or failure of social programs in health, education, welfare, and urban planning. Stress on evaluation of policy alternatives and planning problems. For advanced students in the social sciences and in the various human service schools of the University.

SOC 3335 Seminar in Symbolic Interaction

The social psychology of groups as found in the works of Mead, Becker, Blumer, Goffman, and others.

SOC 3336, SOC 3337, SOC 3338 Seminar on Socialization I, II, III

I) Instructor reviews theories and findings in organizational socialization. II) Students are expected to design studies in organizational socialization. III) Students are required to present results of their studies. *Not open to first year students.*

SOC 3345 Community Analysis

Ecological theories of human relations with the physical environment. Development of the concept of, and discussion of methods for, community study. Comparison between rural communities and urban neighborhoods. Discussion and evaluation of community action programs.

SOC 3347 Seminar in Urban Social Policies

Social science theories and methods evaluated from the perspectives of urban affairs. *Consent of instructor.*

SOC 3355 Political Sociology

Sociological analysis of power relations and power systems with special attention to the bases of political power, processes of change in power, and the part played by violence and revolutionary movements.

SOC 3357 Comparative Socialism

Analysis of twentieth century socialism from a comparative perspective. The variety of "socialisms" that have developed in the Soviet bloc, China, Yugoslavia, and Cuba, as well as Western social democracy (Sweden) and Eurocommunism. Topics include po-

litical structure, class relations, industrial organization, cultural formations, dynamics of change, and democratization.

SOC 3360 Social Stratification

Theories of inequality between groups in historical perspective, from classical to modern industrial times. Discussion and evaluation of sociological research in social stratification with regard to different social and cultural groups.

SOC 3365 Social Movements

A study of various movements for social change from all points of the political spectrum. Special attention will be given to the structural context, as well as to such processes of social movements as social base, leadership, strategy, and organization.

SOC 3390, SOC 3391 Seminar in Social Structure I, II

Seminar relating current theories and research in sociology, social psychology, and social anthropology.

SOC 3405 Theories of Criminology

Theories and philosophies underlying various correctional systems. Schools of thought in criminology and penology. Theoretical approaches to the crime and delinquency problem from the beginnings of criminology to current thinking.

SOC 3410, SOC 3411, SOC 3412, 3 Q.H. each SOC 3413 Contemporary Issues in Sociology

Contemporary issues in sociology. Supervised readings and written reports on special problems.

SOC 3430 Latin American Societies

Study and analysis of selected Latin American societies with particular attention to such countries as Cuba, Mexico, Peru, and Brazil. Emphasis on urbanization and industrialization, social and political change.

SOC 3431 Middle East Area Study

Sociocultural analysis of the Middle East. Ecological, structural, institutional, and normative factors in nomadic, rural, and urban life. Comparative regional analysis.

SOC 3470 Sociology of Religion

A sociological analysis of religious institutions and experiences in their historical and contemporary content. Religion context and political context are considered.

SOC 3485 Computers and Society

Graduate seminar on the social impact of the computer "revolution" on the contemporary world. Topics include conditions of work, education, recreation, privacy, the computer science profession, paradigms of human thought, politics, and social change in the world economy.

SOC 3600, SOC 3601, SOC 3602 3 Q.H. each Seminar

Discussion of selected topics in the field of sociology.

SOC 3603 Rhetoric in Sociology

Critical examination of the conventional forms of sociological writings. How conventions differ by theoretical perspective and paradigm.

SOC 3615 Tutorial in Teaching 3 credits max.

Discussion of issues and problems in teaching. This is a required course for all doctoral candidates and should be taken during a quarter when the student has major responsibility for designing and executing a course in either sociology or anthropology. Open to doctoral candidates only.

**SOC 3620, SOC 3621, SOC 3622 1 Q.H. each
Doctoral Proseminar**

This course is required of all doctoral candidates and is designed to help socialize them for participation as professional sociologists and anthropologists. Topics discussed include the nature of intellectualism and the functions of an intellectual in society today, the university as a structure and as a community of scholars, the nature of professional organizations, teaching sociology and anthropology,

the organization of sociological and anthropological research, ethics in the profession, the nature of applied sociological and anthropological work. The course offers participants the opportunity to acquire practical experience in self-presentation and giving colloquia. *Prep.: SOC 3321 and SOC 3300 or SOC 3301 or SOC 3302 or consent of the instructor.*

SOC 3798 Master's Thesis Continuation 0 Q.H.**SOC 3799 Doctoral Dissertation Continuation 0 Q.H.****SOC 3800, SOC 3801, SOC 3802 Max.: 9 Q.H.
Directed Study in Sociology**

Reading and research under the direction of a faculty member. *Open to doctoral candidates only.*

SOC 3810 Master's Paper in Sociology 6 Q.H.

Empirical or library research meeting the criteria for publication in a professional journal. *Supervision by members of the department.*

SOC 3820 Doctoral Dissertation (No credit)

Biology

BIO 3509 Principles of Systematics 2 Q.H.

Presentation of theories and techniques employed in systematics; rules according to the International Codes of Zoological and Botanical Nomenclature.

BIO 3510 Environmental and Population Biology 2 Q.H.

Physiochemical factors influencing and influenced by organisms. Interaction among individual organisms and among species. Students are expected to participate in lectures and laboratories given for BIO 1211. Individual work on specialized aspects of ecology is assigned. *Prereq.: One year of general biology, including plant and animal biology. Open only to graduate students completing deficiencies in entrance requirements.*

BIO 3511 Aquatic Ecology 3 Q.H.

Chemical, physical, and biotic features influencing coastal, lake, and stream communities. Lectures. *Prereq.: BIO 1211 or BIO 3510 or equivalent.*

BIO 3512 River Ecology Laboratory 3 Q.H.

Two four-hour sessions per week (combined lecture and lab). Chemical determinations, measurement of primary and secondary production, organismal identification in flowing waters of different types.

BIO 3517 Lake Ecology Laboratory 3 Q.H.

Two four-hour sessions per week (combined lecture and lab). Chemical determinations, measurement of primary and secondary production, organismal identification in lakes of different types.

BIO 3518 Ecology of Salt Marshes 3 Q.H.

Survey of fauna and flora, environmental factors affecting them, and current biological and social prob-

lems associated with salt marshes. This course will meet for two lectures of one and one-half hours each, and one full day of laboratory for six weeks during the summer quarter. *Prereq.: BIO 1211 or BIO 3511 or equivalent.*

BIO 3519 Ecology of Rocky Shores 4 Q.H.

Examination of current ecological concepts regarding rocky intertidal and subtidal communities. The influence of biotic and abiotic factors on composition, distribution, and diversity of plant and animal species is emphasized.

BIO 3520 Environmental Microbiology 4 Q.H.

The microbial environment and ecology of the cell. Interactions between microbial populations, 'stressing' soil and fresh-water associations. *Prereq.: BIO 1320 or equivalent.*

BIO 3521 Food Microbiology 3 Q.H.

Microbiology of food with emphasis on pathogenic types and their interactions with other groups indigenous to food. Food fermentations, food processing, and environmental factors influencing growth and development of microorganisms in food. *Prereq.: BIO 1320 or equivalent.*

BIO 3522 Food Microbiology Laboratory 2 Q.H.

Detection, quantification, and isolation of microorganisms and their products of significance in food with emphasis on the pathogenic types. *Prereq.: BIO 3521 (may be taken concurrently).*

BIO 3527 Animal Virology 3 Q.H.

Physical and chemical properties of viruses, viral replication, genetics, cytopathology, and tumor viruses. Medical virology, including pathogenesis,

clinical features, epidemiology, and immunization of the common viral diseases. *Prereq.: BIO 1320 or equivalent.*

BIO 3528 Animal Virology Laboratory 2 Q.H.
Cultivation and identification of viruses. Use of animals, eggs, and animal cell cultures for viral assays. *Prereq.: BIO 3527 (may be taken concurrently).*

BIO 3530 Plant Nutrition and Metabolism 4 Q.H.
Mineral nutrition, photosynthesis, metabolic pathways, and translocation in higher plants.

BIO 3531 Plant Growth and Reproduction 4 Q.H.
Plant hormones, growth, development, and physiology of reproduction. *Prereq.: BIO 3530.*

BIO 3547 Biomechanics I, Theory 4 Q.H.
An introduction to engineering theory and techniques as applied to the disciplines of morphology, evolution, and ecology. Topics include material properties, structural elements and systems, and elementary fluid dynamics. Laboratory emphasizes biological materials in a mechanical sense, the physical biology of flow, and an examination of the fundamental principles of physical laws that affect living organisms. *Prereq.: Permission of instructor.*

BIO 3548 Biomechanics II, Applications 4 Q.H.
A forum for research in biomechanics in which students are expected to develop and execute a research project. In addition, current areas of biomechanical research will be reviewed and evaluated. *Prereq.: BIO 3547 and permission of instructor.*

BIO 3549 Physiology and Biomechanics of Animal Activity 3 Q.H.
An integrated study of the physiological and biomechanical systems that support locomotory activity in animals. The first part is devoted to the structure and function of skeletal muscle and to respiratory and cardiovascular adaptations for activity. The remainder integrates physiological and biomechanical information related to flying, swimming, and terrestrial locomotion. *Prereq.: General physiology.*

BIO 3550 Cardiovascular Physiology 3 Q.H.
Physiology of blood cells, anemia, polycythemia immunity, and allergy. Electrophysiology of the heart, cardiac cycle, EKG, hemodynamics, capillary dynamics, pulmonary circulation, cardiovascular reflexes, cardiac output, and venous return. Cardiac failure, coronary circulation, atherosclerosis, hypertension, cerebral circulation, circulatory shock.

BIO 3551 Cardiovascular Physiology Laboratory 1 Q.H.
Three hours of laboratory study per week. *Prereq.: BIO 3550.*

BIO 3552 Osmotic and Ionic Regulation 2 Q.H.
Comparative physiology of regulation and transport of water and the principle solutes in animals. Principles and underlying mechanisms will be discussed, as well as examples selected from a variety of phyla. *Prereq.: Basic physiology.*

BIO 3558 Vertebrate Endocrinology 3 Q.H.
Principles of hormonal regulation of physiological processes in vertebrates, mechanisms of hormone action, neuroendocrine relationships.

BIO 3559 Animal Nutrition 2 Q.H.
Detailed consideration of organic and inorganic nutritional requirements of humans and selected animals. Digestion, absorption, and metabolism of nutrient materials. Role of vitamins, minerals, and trace elements in metabolism. Variation in nutritional needs among normal individuals and in various physiological and genetic pathologies. Evaluation of food additives and of permissible levels of toxic materials in food. *Prereq.: Basic biochemistry or consent of instructor.*

BIO 3560 Genetics and Developmental Biology 2 Q.H.
Elaboration of the classic laws of heredity, including cytogenetics and chemical basis of heredity. Selected examples of the development of form and function. Students are expected to participate in lectures and laboratories given for BIO 1260 and are assigned extra individual work. *Prereq.: General biology. Open only to graduate students completing deficiencies in entrance requirements.*

BIO 3561 Cell Physiology and Biochemistry 2 Q.H.
Basic chemical and physical processes of cells related to their fine structure; oxidative and intermediary metabolism, photosynthesis, membrane phenomena; movement; chemical and physical processes of prokaryotic and eukaryotic cells. Students are expected to participate in lectures and laboratories given for BIO 1261. Extra, individual work is assigned. *Prereq.: General biology, college physics, and organic chemistry. Only open to graduate students completing deficiencies in entrance requirements.*

BIO 3562 General Biochemistry 3 Q.H.
A survey of the field of biochemistry with emphasis on protein structure, enzyme catalysis, bioenergetics, chemistry and metabolism of carbohydrates, lipids, amino acids, and nucleotides, and the synthesis and function of macromolecules in the context of organelle development. *Prereq.: Permission of instructor. Required of all entering graduate students in biochemistry, cell physiology, and molecular biology. Students may be exempted by successfully completing the final examination from a previous year's course.*

BIO 3567 General Biochemistry Laboratory 3 Q.H.
An intensive course intended to introduce the student to modern research technique used in biochemistry and molecular biology. Topics include purification and characterization of proteins, kinetic properties of enzymes, isolation of high molecular weight DNA, recombination of DNA molecules in vitro, isolation of bacterial clones containing recombinant molecules, and in vitro mutagenesis. The course includes two hours of lecture and six hours

of laboratory, all in one day. Lectures will include a discussion of safety and moral concerns raised by uses of genetic engineering. Required of all entering graduate students in biochemistry, cell physiology, and molecular biology.

BIO 3569 Microbial Genetics 3 Q.H.

Principles and practical application of the genetics of microorganisms. Genetic exchange in bacteria mediated by bacteriophage and plasmids is emphasized. Several eukaryotic systems are also discussed. *Prereq.: BIO 1320 or equivalent.*

BIO 3572 Biology of Meiofauna 2 Q.H.

Systematics and ecology of marine interstitial fauna. *Prereq.: Invertebrate zoology.*

BIO 3577 Malacology 4 Q.H.

Functional morphology, embryology, systematics, and ecology of the major groups of molluscs. *Prereq.: Invertebrate zoology.*

BIO 3601 Biological Electron Microscopy 4 Q.H.

Techniques of electron microscopy applied to biological materials. Specimen preparation, fixation, thin-sectioning, staining, operation of electron microscope, photographic techniques, interpretation of electron micrographs. Student seminars and project required. *Prereq.: Consent of the instructor.*

BIO 3607 Advanced Developmental Biology 3 Q.H.

Study of current concepts of animal and plant development at the molecular and physiological levels. Among topics of discussion are nucleic acid and protein synthesis in development, metabolic activation at fertilization, regulation of the eukaryotic genome, control of cell differentiation, and molecular communication between cells. Reading and interpretation of the primary literature is stressed. Three hours of lecture per week.

BIO 3608 Advanced Developmental Biology Laboratory 2 Q.H.

Analysis of the fundamental problems of development through experimental techniques. Culture of vertebrate and invertebrate embryos, microsurgical analysis of morphogenesis, biochemistry of development, cell-cell interactions, and organ and tissue culture are studied. Five hours of laboratory per week. *Prereq.: BIO 3607 or consent of the instructor.*

BIO 3609 Cellular Aspects of Development 3 Q.H.

Study of animal and plant development at the cellular level. Among discussion topics are cell-cell interaction, cell surface differentiation, differential cell adhesion, genetic and epigenetic control or pattern formation, and ultrastructural aspects of fertilization and development. Reading and interpretation of the primary literature are stressed. Three hours of lecture per week.

BIO 3610 Human Ecology 4 Q.H.

Human tolerances for natural and unnatural environmental factors and man's activities affecting these factors. Man, food, and population dynamics.

BIO 3617 Environmental Law 2 Q.H.

The scientific information required for implementation of the legal and political aspects of environmental management. The role of the scientist as an expert witness. Scientific and legal predictability. Analyses of suitable dynamic models and case law with the goal of improving the results of legal, political, and scientific decisions bearing upon remedial environmental management. *Prereq.: Biology core and first course in physiology, e.g., BIO 1258 and BIO 1259.*

BIO 3620 Industrial Microbiology 3 Q.H.

Microorganisms and methods employed in production of products of economic and medical importance, decomposition of wastes, and control of desirable and unwanted processes and biodeterioration. Fermentation processes emphasized. *Prereq.: BIO 1420 or equivalent, or consent of instructor.*

BIO 3621 Industrial Microbiology Laboratory 2 Q.H.

Laboratory and discussion seminar sessions devoted to the study of selected commercial processes.

BIO 3652 Comparative Neurobiology 3 Q.H.

A cellular approach to structure and function of the nervous system. Topics to be covered include neuronal anatomy, cellular properties of single neurons, synaptic transmission, integration in nerve cells, nerve networks, sensory systems, motor systems, sensory-motor integration, specification of neuronal connectivity, and phylogeny of nervous systems. *Prereq.: General (animal) physiology.*

BIO 3657 Neurophysiology Laboratory 2 Q.H.

Introduction to neurophysiological methods. *Prereq.: BIO 3652 (may be taken concurrently).*

BIO 3661 Human Genetics 3 Q.H.

Application of basic genetic principles to the study of variability in humans. Course focuses primarily on cytogenetics, biochemical genetics, monogenetic, and multifactorial inheritance and population genetics. Topics of special interest include sex determination and differentiation, early embryology, twinning, birth-defect etiology, prenatal diagnosis, and genetic counseling. *Prereq.: BIO 1260 or equivalent.*

BIO 3667 Biochemistry Laboratory 3 Q.H.
Rotation I

Experience is gained in biochemical research by spending six weeks in each of two laboratories during the winter quarter. Required of all first-year graduate students in biochemistry, cell physiology, and molecular biology.

BIO 3668 Biochemistry Laboratory 3 Q.H.
Rotation II

A continuation of BIO 3667 during the spring quarter.

BIO 3669 Biochemistry Laboratory 3 Q.H.
Rotation III

A continuation of BIO 3668 during the summer quarter intended for students who have not yet chosen a laboratory in which to carry out thesis work. Not recommended except where necessary.

BIO 3670 Developmental Biology of Marine Invertebrates 5 Q.H.

Descriptive and experimental studies of embryonic and larval development of marine invertebrates. Laboratory work includes observation and experimentation using live material from a broad spectrum of invertebrate phyla (Marine Science and Maritime Studies Center).

BIO 3672 Ichthyology 4 Q.H.

Natural history and systematics of fishes, with emphasis on marine species (Marine Science and Maritime Studies Center). *Prereq.: Comparative anatomy or vertebrate zoology.*

BIO 3690 Seminar 1 Q.H.

Various topics and recent developments in botany, biochemistry, microbiology, molecular biology, physiology, and zoology are covered in depth. Student presentations are emphasized. To facilitate the planning of assignments, students are urged to contact the instructor during the quarter before the seminar is to be offered.

BIO 3691 Special Topics (credit variable) in Biology

Special study of a selected topic under direction of a faculty member, preliminary to submission and approval of M.S. thesis proposal or M.S. literature dissertation proposal. Topic and direction of study to be arranged with the faculty member supervising the study. Credits convertible to M.S. thesis or M.S. dissertation.

BIO 3692 Special Investigations (credit variable) in Biology

Studies of a topic not directly related to research being pursued for a thesis or dissertation. May take the form of a special course.

BIO 3697 M.S. Thesis (credit variable)

Research methods of some special field and their application to a specific problem, under direction of a graduate faculty member.

BIO 3698 M.S. Literature (credit variable) Dissertation

An extensive literature research under the direction of a graduate faculty member leading to a compre-

hensive written review of a significant biological problem and an oral examination.

BIO 3699 Ph.D. Dissertation

Original research in depth, representing a significant contribution of new biological knowledge, and a written dissertation thereon, under the supervision of a graduate faculty member.

BIO 3798 Master's Thesis Continuation 0 Q.H.**BIO 3799 Doctoral Dissertation Continuation 0 Q.H.****INT 3101 Biochemistry I 2 Q.H.**

Description of the components of biochemistry, including the chemistry of carbohydrates, lipids, prostaglandins, steroid hormones, amino acids, polypeptides, proteins, purines, pyrimidines, nucleosides, and nucleic acids. Consideration of Henderson-Hasselbalch expression, buffers, and importance of pKa. *Prereq.: two quarters of organic chemistry.*

INT 3102 Biochemistry II 2 Q.H.

Discussion of enzymes, enzyme kinetics, and mechanisms of enzyme reactions. An introduction to the methods used to study intermediary metabolism, bioenergetics, biological oxidation reduction reactions, and the electron transport chain. A consideration is made of carbohydrate metabolism, including the citric acid cycle, the Embden-Meyerhoff pathway, and the pentose phosphate pathway. Use of isotopes in biochemistry and the role of high-energy phosphate compounds are outlined. *Prereq.: INT 3101.*

INT 3103 Biochemistry III 2 Q.H.

Lipid metabolism is presented, including the fatty acid cycle, biosynthesis of fatty acids, and biological formation of prostaglandins, cholesterol, and steroid hormones. The metabolism of various amino acids is considered, including the urea cycle, one-carbon fragments, transamination reactions and aromatic hydroxylations. Metabolism of nucleic acids and their building blocks are discussed, as well as the genetic basis of protein synthesis, genetic code, and mechanisms of control. *Prereq.: INT 3102.*

Chemistry

All courses carry two quarter-hours of credit unless otherwise specified.

CHM 3231 Remedial Analytical Chemistry 1 Q.H.

A beginning course in analytical chemistry for those thesis students whose background in the subject is deemed inadequate. *Prereq.: Permission of the departmental faculty is required.*

CHM 3271 Remedial Organic Chemistry I 1 Q.H.

A beginning course in organic chemistry for those thesis students whose background in the subject is deemed inadequate. *Prereq.: Permission of the departmental faculty is required.*

CHM 3272 Remedial Organic Chemistry II 1 Q.H.

Continuation of CHM 3271. *Prereq.: Permission of the departmental faculty is required.*

CHM 3273 Remedial Organic Chemistry III 1 Q.H.

Continuation of CHM 3272. *Prereq.: Permission of the departmental faculty is required.*

CHM 3381 Remedial Physical Chemistry I 1 Q.H.

A beginning course in physical chemistry concentrating on chemical thermodynamics for those thesis

students whose background in the subject is deemed inadequate. *Prep.: Permission of the departmental faculty is required.*

CHM 3382 Remedial Physical Chemistry II 1 Q.H.
Continuation of CHM 3381 concentrating on phase equilibria, solutions, kinetic theory of gases, chemical kinetics. *Prep.: Permission of the departmental faculty is required.*

CHM 3383 Remedial Physical Chemistry III 1 Q.H.
A beginning course in physical chemistry concentrating on quantum chemistry, particles and waves, Schrodinger wave mechanics for those thesis students whose background in the subject is deemed inadequate. *Prep.: Permission of the departmental faculty is required.*

CHM 3401, CHM 3402, CHM 3403 Special Topics in Chemistry: Chemistry and Society I, II, III

Special topics of current importance, including chemical aspects of the environment: pollution and its determination, pesticides, carcinogenics, resources; chemical aspects of energy conversion and storage: fossil fuels and fuel analysis; nuclear reactors; storage batteries; hydrogen production and storage; solar energy, photovoltaic cells and photochemistry; energy-related materials. *Prereq.: Bachelor's degree in science or engineering.*

CHM 3420 Modern Methods of Analysis 2 Q.H.
Similar to CHM 3430, but without laboratory. *Prereq.: Consent of instructor.*

CHM 3430 Modern Methods of Analysis 3 Q.H.
Training in a wide variety of modern methods of instrumental analysis with extensive "hands-on" experience offered by a laboratory section. Areas covered include: data handling; spectroscopy (UV-visible, infrared, luminescence, atomic absorption, atomic emission, mass spectrometry); separations (gas, thin-layer, high performance liquid chromatography); electrochemical methods (LCEC, amperometry, coulometry, polarography, etc.); computerized instrumentation; hyphenated methods of trace organic/inorganic analysis; forensic and clinical applications of modern methods of analysis. (*Restricted to students in the Forensic Chemistry MS and PhD programs, Clinical Chemistry MS and PhD programs, and others by special arrangement.*)

CHM 3431 Remedial Instrumental Analysis 1 Q.H.
A beginning course in instrumental analysis for those thesis students whose background in the subject is deemed inadequate. *Prereq.: Permission of the departmental faculty is required.*

CHM 3441 Remedial Inorganic Chemistry 1 Q.H.
A beginning course in inorganic chemistry for those thesis students whose background in the subject is deemed inadequate. *Prereq.: Permission of the departmental faculty is required.*

CHM 3461 Remedial Identification of Organic Compounds 1 Q.H.

A beginning course in the identification of organic compounds dealing with the qualitative analysis of

organic compounds and mixtures, using physical methods for those thesis students whose background in the subject is deemed inadequate. *Prereq.: Permission of the departmental faculty is required.*

CHM 3501 Polymer Chemistry I

Introduction to polymers. Major emphasis on synthesis. Step-reaction, chain-reaction, and ring-opening polymerizations. Copolymerization. Three-dimensional polymers and crosslinking. *Prereq.: One year of organic chemistry and one year of physical chemistry.*

CHM 3502 Polymer Chemistry II

Physical chemistry of polymers in solution and bulk. Molecular characterization. Mechanical and physical properties in the glassy, rubbery, viscous, and semicrystalline states. *Prereq.: CHM 3501.*

CHM 3503 Polymer Chemistry III

Industrial practice, polymer processing, fibers, elastomers, coatings, adhesives, and reinforced plastics. Relationship of polymer structure to usage. *Prereq.: CHM 3502.*

CHM 3510 Special Projects (maximum: 4 Q.H.) in Chemistry

Laboratory studies for non-thesis research. *Prereq.: Permission of the departmental faculty is required.*

CHM 3521 Analytical Separations

Theory and practice of analytical separation techniques. Emphasis is on fundamentals as they relate to practice. Topics for examination are based mainly on chromatographic processes including gas and high speed liquid chromatography. Other topics include zone refining, liquid-liquid extraction, and electrophoresis.

CHM 3522 Advanced Analytical Separations.

Continuation of CHM 3521. *Prereq.: CHM 3521.*

CHM 3523 Electroanalytical Chemistry I

The theory, instrumentation and applications of equilibrium and non-equilibrium techniques. A selection will be made from among the following topics: potentiometry, potentiometric titrations, voltammetry, coulometry, chronopotentiometry and conductance measurements.

CHM 3524 Electroanalytical Chemistry II

A continuation of CHM 3523 emphasizing recent advances in electroanalytical instrumentation and application. Topics to be covered include ion-selective electrodes, processes at electrode surfaces, and novel voltammetric techniques. *Prereq.: CHM 3523.*

CHM 3525 Optical Methods of Analysis I

Theory and principles of molecular absorption and emission processes, instrumentation for optical methods of analysis, specific applications and approaches for use of optical methods. Specific topics include: ultraviolet-visible, fluorescence/phosphorescence, infrared, Raman, refractometry, interferometry, polarimetry, circular dichroism, optical rotatory dispersion, light scattering for polymer analysis, optical absorption/emission detectors for HPLC,

chemiluminescence, micellar enhancement in spectroscopy, and other special topics of recent development and application.

CHM 3526 Optical Methods of Analysis II

Principles and applications of atomic spectroscopy. A selection will be made from among the following topics: atomic emission, atomic absorption, atomic fluorescence, x-ray absorption, fluorescence and diffraction, and electron spectroscopy. *Prereq.: CHM 3525.*

CHM 3527 Analytical and Organic Mass Spectrometry

Theory and practice of mass spectrometry in chemical analysis. Principles of formation of mass spectra of organic compounds. Modern ancillary techniques using mass spectrometric detectors. *Prereq.: One year of organic chemistry and instrumental analysis.*

CHM 3529 Chemical Instrumentation I: Measurements and Control

A lecture laboratory course illustrating the design of electronic instruments used for chemical measurements. Topics include circuit analysis, transducer characteristics, circuits using basic semiconductor devices, integrated circuits, signal amplification and signal processing. Interfacing and interrelation of circuits is emphasized.

CHM 3530 Chemical Instrumentation II: Computer Interfacing

A lecture laboratory course illustrating the interface to chemical instruments. Topics include digital logic, computer architecture, data processing, A/D and D/A conversions, and parallel and serial input/output. Standard interfaces such as the 20 ma current loop, RS-232C and the IEEE-488 GPIB are covered in detail. *Prereq.: CHM 3529.*

CHM 3531, CHM 3532 Topics in Analytical Chemistry I, II

Selected topics of current importance in analytical chemistry. *Prereq.: Consent of instructor.*

CHM 3541 Advanced Inorganic Chemistry I

Application of basic quantum chemistry to inorganic systems. Russell-Saunders and j-j coupling. Stereochemistry of nontransition-metal compounds, bonding and structure of electron-deficient systems.

CHM 3542 Advanced Inorganic Chemistry II

Magnetic properties; electronic spectra and selection rules. Thermodynamic stability of coordination compounds. Experimental techniques of inorganic chemistry. *Prereq.: CHM 3541.*

CHM 3543 Advanced Inorganic Chemistry III

Crystal symmetry. Introduction to theory of solids; semi-conductors and metals; non-stoichiometric compounds; solid-state reactions. Application of molecular orbital theory. Determination of electron distribution in transition metal compounds. Mossbauer spectroscopy and advanced magneto-chemistry. *Prereq.: CHM 3542 and CHM 3591.*

CHM 3561, CHM 3562 Advanced Organic Chemistry I, II

An intensive survey of organic reactions. Modern concepts of structure and mechanism are used to correlate factual material. *Prereq.: One year of organic chemistry.*

CHM 3563 Physical Organic Chemistry

Topics in basic physical organic chemistry: molecular polarity, equilibrium and kinetics, reactivity and structure, solvent effects, acid-base catalysis, orbital symmetry, aromaticity. *Prereq.: CHM 3562 or consent of instructor.*

CHM 3564 Spectrometric Identification of Organic Compounds

Interpretation of the ultraviolet, infrared, and nuclear magnetic resonance spectra of organic compounds. *Prereq.: One year of organic chemistry.*

CHM 3581 Chemical Thermodynamics I

First Law of Thermodynamics, Thermochemistry Second and Third Laws, free energies, reaction end phase equilibria. *Prereq.: Consent of instructor.*

CHM 3582 Chemical Thermodynamics II

Partial molar properties, solutions, electrolytes. Statistical analogues of entropy and free energy, partition functions. *Prereq.: CHM 3581.*

CHM 3583 Chemical Thermodynamics III

Statistical thermodynamics applied to gases, liquids, and solids. Irreversible thermodynamics. *Prereq.: CHM 3582 and CHM 3592.*

CHM 3591 Introductory Quantum Chemistry I

Introduction to quantum mechanics. Application to simple systems. Perturbation theory and applications. Harmonic oscillator, rigid rotor and applications to microwave and infrared spectroscopy. Simple atoms. *Prereq.: One year of physical chemistry.*

CHM 3592 Introductory Quantum Chemistry II

The variational method. The chemical bond. The LCAO method. Group theory and applications. Molecules. Woodward-Hoffman rules. *Prereq.: CHM 3591.*

CHM 3593 Introductory Quantum Chemistry III

Application of group theory and simple approximate theories to conjugated molecules. The SCF method and its application to atoms and molecules. Applications to molecular spectroscopy. *Prep.: CHM 3592.*

CHM 3594 Chemical Kinetics

Use of experimental data to deduce the rate law of a reaction. Mechanisms deduced from rate laws. Influence of experimental error on precision of rate constants and activation energies. Collision- and transition-state theories of reaction rates. *Prereq.: One year of physical chemistry.*

CHM 3641 Coordination Chemistry

Solution phase properties of coordination compounds. Experimental methods for the study of thermodynamics stability and kinetic lability. Kinetics and mechanism of solvent exchange and substitution re-

actions at transition metal centers. Classification of redox reaction mechanisms. Marcus theory. Phenomenological mechanisms. *Prereq.: CHM 3543.*

CHM 3642, CHM 3643, CHM 3644, CHM 3645
Special Topics in Inorganic Chemistry I, II, III, IV

Advanced topics of importance in inorganic chemistry including advanced ligand field theory: crystal field theory of ions in weak and strong fields. Molecular orbital theory of transition metal complexes. Crystal structure determination in solids: crystallography, X-ray, electron and neutron diffraction techniques applied to inorganic, bio-inorganic and other solids. Resonance spectroscopy in inorganic chemistry, including electron spin, nuclear magnetic, and nuclear quadrupole resonance; and Mossbauer spectroscopy. Solid-state chemistry: thermal, magnetic and transport properties; phase transformations and crystal defects; surface effects, material preparation techniques. *Prereq.: CHM 3542 and consent of instructor.*

CHM 3661, CHM 3662 Organic Stereochemistry and Reaction Mechanisms I, II

Interrelations of the stereochemistry of organic molecules with their physical and chemical behavior. Conformational analysis. The effects of spatial relationships on transition states, equilibria, and reaction rates as an introduction to the study of organic reaction mechanisms. *Prereq.: CHM 3563.*

CHM 3663, CHM 3664 Organic Reaction Mechanisms and Organic Synthesis I, II

The fundamental factors influencing the courses of organic reactions. Substitution reactions. Pericyclic reactions. Synthetic methods as an introduction to organic synthesis. *Prereq.: CHM 3662 or concurrent registration therein.*

CHM 3671, CHM 3672, CHM 3673 Special Topics in Organic Chemistry I, II, III

Selected topics of current importance in organic chemistry. *Prep.: CHM 3562 and consent of instructor.*

CHM 3681, CHM 3682, CHM 3683 Special Topics in Physical Chemistry I, II, III

Advanced topics of importance in physical chemistry including quantum chemistry: linear algebra and the

formulation of quantum theory. Angular momentum. Group theory. Small molecules. Time-dependent theory and selected advanced topics. Statistical mechanics. Quantum statistics; electrons in metals, photons, and phonons; superconductivity; fluctuations, noise, and irreversible thermodynamics; transport phenomena; phase transitions of high order. *Prereq.: Consent of instructor.*

CHM 3800, 3801, 3802, 3803 Seminar 1 Q.H.

Oral reports by the participants on current investigations in chemistry. *Prereq.: Enrollment in full-time program.*

CHM 3810 Research for M.S. (Maximum: 14 Q.H.)

Original research, under supervision of a faculty member, leading to a written thesis thereon or to the establishment of doctoral candidacy.

CHM 3820 Research and Dissertation for Ph.D.

Original research in depth, representing a significant contribution of new chemical knowledge, and a written dissertation thereon, under the supervision of a faculty member. *Prereq.: Doctoral candidacy.*

INT 3101 Biochemistry I

Discussion of the structures and chemistries of carbohydrates, proteins, lipids, nucleic acids, and selected cofactors. *Prereq.: One year organic chemistry.*

INT 3102 Biochemistry II 2 Q.H.

Discussion of enzymes, enzyme kinetics, and mechanisms of enzyme reactions, of intermediary metabolism and of bioenergetics, biological oxidation-reduction reactions and the electron transport chain. A consideration is made of carbohydrate metabolism including the glycolytic pathway, the citric acid cycle and the pentose phosphate pathway. *Prereq.: INT 3101. Offered summer and winter quarters.*

INT 3103 Biochemistry III

Continuation or intermediary metabolism from Biochemistry II, including lipid, protein, and nucleic acid metabolism, photosynthesis, and cell regulation. *Prereq.: Biochemistry II, INT 3102.*

Economics

All courses carry three quarter-hours of credit unless otherwise specified. Courses indicating macroeconomics theory as a prerequisite refer to ECN 3120 (for M.S. degree students) and ECN 3220 (for M.A. degree students).

ECN 3010 Introduction to Microeconomic Theory

0 Q.H.

Intensive coverage of basic micro theory. This course is designed for M.A. degree students who need to improve their background in micro theory and carries no academic credit toward the M.A. or Ph.D. programs.

ECN 3020 Introduction to Macroeconomic Theory

0 Q.H.

Intensive coverage of basic macro theory. This course is designed for M.A. degree students who need to improve their background in macro theory and carries no academic credit toward the M.A. or Ph.D. programs.

ECN 3030 Introduction to Mathematics for Economists 0 Q.H.

This course helps acquaint students with matrix algebra and elementary calculus necessary for quantitative economics: simultaneous linear systems; polynomial, logarithmic, and exponential functions; and elementary differential and integral calculus. *This course offers no credit toward a degree in economics.*

ECN 3040 Introduction to Statistics 0 Q.H.

An introduction to statistical methods and techniques used in economic analysis. Descriptive statistics, time-series and index number problems, sampling problems, introduction to probability theory, and hypothesis testing. This course is designed for M.A. degree students who need to improve their background in basic statistics and carries no academic credit toward the M.A. or Ph.D. programs.

ECN 3110 Introduction to Microeconomic Theory

The price mechanism, competitive and noncompetitive markets, accounting of the firm, production analysis, consumption analysis, labor markets (wage theory), income distribution, and welfare economics. (4 cr. for MSEPP)

ECN 3120 Introduction to Macroeconomic Theory

National income definitions and measurements, Keynesian models, multipliers, growth models, investment, consumption and monetary theories. (4 cr. for MSEPP)

ECN 3130 Introduction to Mathematics for Economists

Seeks to acquaint the student with the algebra and elementary calculus necessary for quantitative economics: simultaneous linear systems; polynomial, logarithmic, and exponential functions; and elementary differential and integral calculus. (3 cr. for MSEPP)

ECN 3140 Introduction to Statistics

An introduction to statistical methods and techniques used in economic analysis. Descriptive statistics, time-series and index number problems, sampling problems, introduction to probability theory, and hypothesis testing. (4 cr. for MSEPP)

ECN 3150 Microeconomic Policy Planning Seminar 4 Q.H.

Cost efficiency and effectiveness, assessment of externalities, shadow prices, benefit-cost analysis, project implementation and evaluation, budget analysis, evaluation of public programs, role of private and public sectors, relationship of projects and macro planning, use of analysis by policymakers. *Prereq.: ECN 3110, ECN 3140 co-requisite.*

ECN 3151 Macroeconomic Policy Planning Seminar 4 Q.H.

Role of public sector in the economy. Socio-economic objectives and public policies. National economic planning and synthesis of models for growth and development. Tools and techniques for economic planning. Construction and utilization of input-output tables. Planning and policy implementation and evaluation. *Prereq.: ECN 3120, ECN 3140 co-requisite.*

ECN 3152 Workshop in Economic Planning and Policy

Empirical work involving micro and macro planning techniques, applying the latter to individual case studies of a specific plan, program, or organization. Students are expected to prepare and present a research paper on a chosen case study, demonstrating the ability to use planning techniques. *Prereq.: ECN 3150 and ECN 3151.*

ECN 3210 Microeconomic Theory I 4 Q.H.

A non-math treatment of microeconomic theory at the beginning graduate level. An investigation of the conditions underlying consumer and producer equilibrium under different objective functions and various market structures. Derivation of product demand curves, supply curves, and factor demand curves for alternative market structures in product and factor markets are surveyed.

ECN 3220 Macroeconomic Theory I 4 Q.H.

Income and employment theory; classical Keynesian, and post-Keynesian aggregate demand and supply systems.

ECN 3240 Statistical Inference 4 Q.H.

A study of statistical methods and techniques. Probability theory and models, testing economic hypotheses, analysis of variance, ordinary least-squares regression, t-statistics and f-statistics. Correlation analysis. *Prereq.: ECN 3040 or statistics examination.*

ECN 3241 Econometrics I 4 Q.H.

Estimation of demand, supply, cost, and production functions; applications of multivariate analysis of economic data; identification; determination of trend, oscillation, and periodic movements; autocorrelation and correlogram analysis, trends in multiple regressions. *Prereq.: ECN 3240 or permission of instructor.*

ECN 3310 Case Studies in Applied Microeconomics

Topics in applied microeconomics. Case studies on organizational decision making for such problems as short-run and long-run forecasting of demand, price policy, financing of investments, location of plants, and response to government regulations and taxation. *Prereq.: ECN 3010 or ECN 3110.*

ECN 3330 Economic Programming

Economic programming with emphasis on linear programming, simulation and queuing theory with applications to the computer. *Prereq.: ECN 3530.*

ECN 3331 Accounting for Economists

An overview of private and public sector accounting systems and techniques to assist students in developing the ability to use these techniques in obtaining data and analyzing problems. Topics covered include national income accounts, balance-of-payment accounts, the private firm's balance sheet, income statement and flow-of-funds statement. Other issues, such as real vs. nominal magnitudes and depreciation techniques, are also covered.

ECN 3332 Computers in Economic Research

This course is designed to provide an introduction to the use of computers in economic research. Top-

ics to be covered include accessing the Northeastern computer, descriptive statistics, regression analysis, matrix manipulation and FORTRAN programming. This course will combine classroom lectures with hands-on use of the computer. While no previous computer experience is required, a knowledge of statistics (ECN 3040/3140) is expected.

ECN 3350 Economics of the Labor Market and Labor Force I

Labor force measurement and determinants, women's changing role in the labor market; micro-analysis of labor supply and demand, varieties of labor markets and their functioning, minimum wages; wage structures and differentials, labor allocation and migration; union impact on wage levels and structures; macro-wage-employment determination, macrowage-price problems, income policies. Applications to developing and developed economies.

ECN 3351 Economics of the Labor Market and Labor Force II

Unemployment and underemployment, technological change and changing skill requirements; income distribution and poverty; human capital theories and human resource development; employment and training policies to raise personal earnings, income maintenance programs. Topics discussed in relation to developing and developed economies.

ECN 3352 Economics of Manpower Planning I

The role of manpower planning and its integration with general development planning. Analysis and evaluation of different techniques of manpower planning. Technological versus economic methods. Practice of manpower forecasting and data problems. Skill training versus educational strategies. Models of educational planning and their applications to different countries. *Prereq.: Microeconomic theory.*

ECN 3353 Economics of Manpower Planning II

Applications of manpower planning methods and techniques to problems of national economic development. Cost-benefit and cost-effectiveness of educational and manpower programs. Special problems of health manpower, scientists, engineers, and technicians. Evaluation of methods and prediction used in national manpower plans. *Prereq.: ECN 3352.*

ECN 3354 Economics of Medical Care and Health Manpower

The organization of medical care, the problems associated with various alternative delivery systems. The utilization and availability of physicians and other paramedical personnel, the growth and pressures exerted by third-party payers; and consideration of federal, state, and municipal participation in the delivery of quality medical care under various alternatives for national health insurance.

ECN 3355 Economics of Education

An examination of the contribution of education to the process of economic growth and the way education is produced and distributed. Special topics

include inequalities in returns to education; the role of intelligence and class background in educational success; and socializing role of education in production.

ECN 3356 Local Labor Markets: Research Methods and Problems

Analytical framework and empirical measures for determining the nature and operation of state and local labor markets. Varieties of local labor markets; use of data from public agencies to examine such markets; composition of local labor force, sources of local labor supply, industrial and occupational mix, local wage and salary structures, local income distribution.

ECN 3357 Human Resources Planning at State and Local Areas

Applied workshop in methods and techniques for planning human resource programs at state and local levels. Economic tools for state employment services, prime sponsors, and other service deliverers for designing, implementing, monitoring, and evaluating employment and training programs. Use of statistical packages in human resources planning.

ECN 3358 Economics of Education and Training Programs

Economic analysis of the relative effectiveness of different education and training programs at the state and local level. Implications of human capital theory; methods for coordinating alternative programs and determining their effectiveness. Rates of return, cost-effectiveness, cost-benefit. Applications to policy and program planning.

ECN 3359 Seminar in Human Resource Development

Selected topics on the development and use of human resources. *Prereq.: Consent of instructor.*

ECN 3360 Regional Economics

Delineating regions. Theories of location for firms, industries, and people. Regional income accounting systems and models of intra- and interregional income determinants and impact analysis. *Prereq.: Microeconomic theory.*

ECN 3361 Externalities

Theoretical foundations for urban and regional economics. Survey of economic theory related to externalities and welfare economics. *Prereq.: ECN 3210 and consent of instructor.*

ECN 3362 Economics of Crime

A discussion of the resource allocation problem as it relates to criminal behavior and effective law enforcement. Evaluation of costs and benefits of alternative law enforcement policies. Criminal activity, including organized crime, is analyzed in an economic context.

ECN 3363 Urban Economic Systems

The economy of cities. Analysis of intrametropolitan spatial relationships including residential location, land, and housing markets. *Prereq.: Microeconomic theory.*

ECN 3364 Urban Economic Development

Continuation of Urban Economic Systems. Problems in urban economics including segregation, housing, transportation, urban renewal, and related policy issues.

ECN 3365 Economics of Urban Transportation

Urban agglomeration, economic activities, residential concentration, and transportation network; urban and suburban densities in relation to the central place, capital budgeting; pricing; costs incidence and externalities of various modes; cost-benefit analysis; effects of transportation patterns on urban socio-economic life; modal split and forecasting economic requirements for integrated urban transport needs.

ECN 3366 Economics of Intercity Transportation

Investigates the rationale for intercity freight and passenger movements within the framework of interregional commodity flows. The choice of mode once traffic volume has been determined. Study also covers the economic and environmental impacts of the choice of mode.

ECN 3369 Urban/Regional Economics Seminar

Selected topics in urban/regional economics. *Prereq.: Consent of instructor.*

ECN 3370 Economic Development

A study of the prospects of economic growth in less developed areas. Measurement and theories of economic development. Role of human and natural resources, education, technology, and capital formation in national, regional, and sectoral development. Changes in institutions.

ECN 3371 Regional Development

Methodology and application of techniques for planning in multiregional systems. Empirical examples.

ECN 3372 Comparative Economic Development

Case studies of less developed countries at differing stages of economic development.

ECN 3373 Development Finance and Trade

Sources of investment finance in developing countries; role of taxation and tax structure reform; development of financial institutions and capital markets; private and official finance from abroad and debt-service problems; problems of monetary management and export instability.

ECN 3379 Development Planning Seminar

Political and economic plans. Survey of neoclassical growth models. Input-output techniques in open and closed models. Elements of linear programming; optimal decision techniques. Processes of implementation of planning; interaction of public and private sectors. Guide to empirical applications. *Prereq.: ECN 3120 or ECN 3220 and ECN 3370 or consent of instructor.*

ECN 3380 Monetary Theory

A study of the relationships between money and economic activity with emphasis upon various quantity theory models and theories of the demand for money and velocity. *Prereq.: Macroeconomic theory.*

ECN 3381 Monetary Policy

A study of the interrelationships between aggregate economic activity, financial markets, and central banking instruments, objectives, and policy.

ECN 3384 Capital Markets

Primary sources of savings and demand for financial assets; role of financial intermediaries; banking system and government lending agencies. Demand for funds and real investment--mortgage, corporate, and government securities markets; interdependence of rate structures. Flow-of-funds data in relation to national income accounts.

ECN 3389 Money, Credit, and Banking Seminar

Selected topics in the economics of money, credit and banking. *Prereq.: Consent of instructor.*

ECN 3390 Public Finance Theory I: Public Expenditures

Fiscal functions and institutions of government; public choice and fiscal politics, theory of public goods; public expenditure analysis and evaluation; fiscal federalism and relationships among governments at different levels, including intergovernmental grants. *Prereq.: Microeconomic theory.*

ECN 3391 Public Finance Theory II: Taxation

Fiscal functions of government; theory of public choice and public goods; principles of taxation; problems of tax structure and reform at the national and local levels, tax incidence and equity; effects of taxation on economic efficiency and growth; issues of public debt and the deficit.

ECN 3392 Public Policy and Finance

Techniques of fiscal policy, fiscal policy norms, public sector debt; tax policy, federal tax reform; the conflict between social implications of price stabilization and full employment; public expenditure policy and the interrelation between monetary and fiscal controls. *Prereq.: Macroeconomic theory.*

ECN 3399 Seminar in Public Finance

Selected topics in public finance.

ECN 3510 Microeconomic Theory II 4 Q.H.

Theory and problems of macro-dynamics, growth, inflation cycles, and stabilization policy. *Prereq.: ECN 3220 and consent of instructor.*

ECN 3511 Economics and the Law 1 Q.H.

Topics in the application of microeconomic principles to the law, such as property rights, torts, contract law, and the regulation of business. Limited to Law, Policy, and Society students.

ECN 3520 Macroeconomic Theory II 4 Q.H.

Theory and problems of macro-dynamics, growth, inflation, cycles, and stabilization policy. *Prereq.: ECN 3220 and consent of instructor.*

ECN 3530 Mathematics for Economics 4 Q.H.

Application of matrix algebra and simple multivariate calculus to economic analysis. Static organization and dynamic analysis; difference and differential equations. Examples from economic theory. *Prereq.: ECN 3030 or mathematics examination.*

- ECN 3540 Econometrics II** 4 Q.H.
Asymptotic and small sample properties of various estimators; rank-order conditions for identification; specification error and error in variables; remedies for autocorrelation and multicollinearity; dummy variables; distributed lags; forecasting and simulation; non-linear estimation; alternative estimation technique (two-stage least squares, three-stage least squares, maximum likelihood estimators, etc.) *Prereq.: ECN 3241.*
- ECN 3601 Doctoral Research Seminar I** 4 Q.H.
Prereq.: 12 q.h. of field work and consent of instructor.
- ECN 3602 Doctoral Research Seminar II** 4 Q.H.
Prereq.: ECN 3601.
- ECN 3798 Master's Thesis Continuation** 0 Q.H.
- ECN 3799 Doctoral Dissertation Continuation** 0 Q.H.

- ECN 3890 Master's Thesis Seminar** (maximum 6 Q.H.)
Thesis supervision by members of the department; approval of graduate adviser required.
- ECN 3895 Readings in Economics**
Supervised reading in selected topics in economics. For Master's students only. *Prereq.: Consent of instructor; approval of graduate director.*
- ECN 3896 Readings in Economics**
Supervised reading in selected topics in economics. For Doctoral students only. *Prereq.: Consent of instructor and approval of graduate director.*
- ECN 3899 Doctoral Dissertation Seminar** (no credit)
Prereq.: Approval of graduate adviser required.

English

All courses carry three quarter-hours of credit unless otherwise specified.

ENG 3300 Introduction to Literary Study

Materials and techniques of research. Writing a research paper. Approaches to literary study with consideration of both traditional and contemporary views.

ENG 3311 English Prose Style

The development of prose style in English (chiefly expository), from the sixteenth century to the present. Most major authors are represented, from Roger Ascham to James Baldwin.

ENG 3312 Theory and Teaching of Writing

Designed for teachers or prospective teachers of writing in college or the public schools, this course examines several premises of writing instruction and how they can provide successful classroom practices.

ENG 3315 Theories of Criticism

An introduction to the study of modern and contemporary literary theory and criticism: "New Critical," Marxist, psychoanalytic, structuralist, poststructuralist, phenomenological, and others.

ENG 3316 Critical Schools

A seminar concentrating on one or several related recent developments in literary theory and criticism such as structuralism or poststructural criticism. The subject of the seminar changes from year to year.

ENG 3317 Topics in Criticism

Examines such topics in critical theory as narrative, cultural criticism, representation, reader response.

ENG 3321 Linguistics and Literary Study

Language viewed in its special function as literary medium. Linguistic approach to style, metaphor, form, and meaning. Representative works of major writers, poetry and prose, studied for characteristic formal properties. Discussion of contribution of linguistic analysis to literary criticism and to a theory of literature.

ENG 3322 Linguistics and the Art of Writing

Aspects of linguistics related to written forms of communication. Both fictional and nonfictional prose are represented. Topics in discourse analysis, textual cohesion, point of view and its effect on syntactic options, syntactic symbolism where syntax replicates meaning. Such problems as language and deception, speech and judgment, rhetoric and persuasion are also considered.

ENG 3323 Theatrical Styles

An examination of modern dramatic expression and theory with particular attention to absurdist drama, existentialist drama, and Brecht's theatre of alienation.

ENG 3324 Perspectives on American Literature

An attempt to discover common themes and recurrent patterns in American literature through a close reading of critics as various in their approach as Lawrence, Parrington, Chase, Pearce, and Fiedler.

ENG 3325 Topics in Early American Literature

Focuses on the work of one writer, a group of writers, or a theme or structure common to several writers—Jonathan Edwards, the poets of the seventeenth and eighteenth centuries, or typology, for example—in the first two hundred years of American literature. Topics change with time and demand.

ENG 3326 Topics in Twentieth-Century American Literature

Varied topics deal with twentieth-century American literature on a thematic, formal, generic, cultural, or interdisciplinary basis. Among the large number of possible topics are: Heroes and Antiheroes in Modern American Fiction, Twentieth-Century American Nature Poetry, Action Painting and the New York School, Women in Twentieth-Century American Literature, Surrealism in Modern and Contemporary

American Poetry, The City in Twentieth-Century American Literature, and Naturalism in the Modern American Novel.

ENG 3327 Major American Novelist

Examines in detail the work of a major American novelist and its historical context and cultural milieu; the work, for example, of Herman Melville, Mark Twain, Henry James, Willa Cather, Ernest Hemingway, or Saul Bellow.

ENG 3328 Major American Playwright

Examines in detail the work of a major American playwright and its theatrical style and social impact; the work, for example, of Eugene O'Neill, Tennessee Williams, Arthur Miller, or Edward Albee.

ENG 3329 Major American Poet

Considers in depth the work of a single major figure. Some likely subjects are: Whitman, Dickinson, Frost, Eliot, Pound, Williams, Stevens, and Lowell.

ENG 3330 American Drama

Surveys American drama from its political beginnings in the eighteenth century to the experimental variety of the twentieth, from Royall Tyler and William Dunlap to Eugene O'Neill and Imamu Amiri Baraka.

ENG 3331 Topics in American Literature

Varied topics deal with American literature on a thematic, formal, generic, cultural, or interdisciplinary basis. Among the large number of possible topics are: The *Isolato* in American Literature, Typology and American Art, Written Women and Women Writers, Realism in American Literature, Southern Literature, Humor in American Literature, The Frontier in American Writing, Local Colorists, and "The Machine in the Garden."

ENG 3348 Research Materials and Methods for Technical Writing

This course will examine research sources in science, technology, and various professions. Such sources include computer searches, on-line data, corporate holdings, and specialized publications in engineering, computer science, the sciences, medicine, and business. Examples are the *IEEE Transactions*, the *New England Journal of Medicine*, U.S. Government publications, and the like. (An annotated list of technical reference guides appears in Houp and Pearsall's *Reporting Technical Information*.)

The course will also explore interviewing experts and using nonprint media as resources in science, technology, and business.

In addition to sources of scientific and technical information, publications in the areas of technical and business communication will be considered. These include the *ITCC Proceedings*, *Technical Communication*, and others, including bibliographies in the area.

In addition, the course will examine style guides particular to branches of technical and scientific writing. These include U.S. Government *Style Manual* (1983), military documentation specifications, the *Chicago Manual of Style*, and various corporate style

guides (Digital Equipment Corporation, IBM, General Electric, and others).

ENG 3349 Workshop in Writing for Publication

This course will examine published articles in scientific, technical, and professional journals and magazines. The articles will be evaluated for content, style, tone, format, and mechanical details. Students will evaluate the article's success, its professionalism, its appropriateness and timeliness, and the professional standards of the journal.

Concurrently, students will research, write, and revise an article for submission to a professional journal of their choice. Members of the class will review and edit these articles before submission. The goal of the course is to have an article accepted for publication.

Technical editing approaches will be included in the course as they are appropriate.

Throughout the quarter, area authors whose articles appear in scientific and technical journals will be asked to present guest lectures, discussing both their field of expertise and their writing efforts. We may be able to call on Alan Leitman, whose column appears in *Science* 83, Tracy Kidder, author of *Soul of a New Machine* and contributor to *OMNI*, and various contributors to area publications such as *Computerworld* and the *New England Journal of Medicine*.

ENG 3350 Creative Writing I

Prose fiction.

ENG 3351 Creative Writing II

Poetry.

ENG 3352 Writing for the Professions

This course examines the various forms of business communications and offers practical experience in writing business letters, memoranda, case studies, proposals, and reports. For students in the Graduate School of Business Administration.

ENG 3353 Problems in Writing

This course examines writing problems in general as well as those which are specific to professional interests.

ENG 3354 Technical Writing

Technical writing assignments, including correspondence, description, instructions, proposals, and reports. Use of graphics, layout techniques, and visual aids. Emphasizes audience definition, editing, and rewriting.

ENG 3355 Topics in Technical Writing

Writing assignments related to computers and the computer industry. Preparation of operator's manual and program documentation (instructions for running a program in a programming language such as BASIC or PASCAL). Course offers experience in editing and revision and work with graphics and layout in preparing assignments.

ENG 3358 Topics in Nonfiction Prose

This course will examine writings in nonfiction prose in such areas as biography, history, science, and technology. The content of the course will vary according to the design of the instructor.

If the course is given as an elective primarily for students in the Master of Technical and Professional Writing program, it should include science writing and writing about technology. Such a course could, for example, be primarily historical, focusing on writers in the nineteenth century and before, including Leonardo DaVinci, Galileo, Newton, Faraday, Darwin and others. An alternate topic might be writing about science and technology for the modern, educated lay audience. Works might be examined for the importance of the technological and scientific developments they cover, for their relation to views about science and technology in modern America, and for the authors' importance as stylists.

ENG 3359 Writing Workshop

This course is designed to provide advanced training in varied forms of writing. In different years, the topics could be such specialized areas as fiction, poetry, professional writing, and writing for academic administrators. In this course, intensive writing will be expected by the student and extensive comment by the professor.

ENG 3360 Writing Workshop

This course is designed to provide advanced training in varied forms of writing. In different years, the topics could be such specialized areas as fiction, poetry, professional writing for academic administrators. Intensive writing will be expected by the student and extensive comment by the professor.

ENG 3361 Topics in Literary Study

Varied topics will deal with literature on a thematic, formal, or generic basis. Some possible topics might be: Literature in the Jazz Age, The Tragic Hero, The Poetry of Nature. Topics will vary from year to year.

ENG 3380 Prose Writing I

This is a course in the writing of various types of nonfiction prose, including reviews, reports, biography, commentary, research, personal narrative, travel, and others developed by the participant in consultation with the instructor. The course will focus on concepts of content, point of view, organization, style, and stages of composition.

ENG 3381 Prose Writing II

This course continues Prose Writing I. The goal of the course is to reinforce writing theory and practice, to introduce the professional concerns of writers, and to prepare writing for possible publication. Participants will refine techniques of composition and will examine the rhetorical methods of description, narration, exposition, and persuasion. The course will review such writers' markets as newspapers, popular magazines, and scholarly journals. When possible, professional writers will be featured as guest speakers.

ENG 3384 Rhetorical Theory

This course will trace the history of rhetoric and examine the major contemporary theories in the field. Consideration will begin with the classical rhetoric of Aristotle, Plato, Cicero, and Quintilian and end with the modern formulations of rhetoric by I.A. Richards, Philip Wheelwright, Alexander Bain, James Moffett, and James Kinneavy.

Rhetoric will be examined in terms of traditional modes of classifying discourse—description, narration, exposition, and persuasion—as well as modern reclassifications—expressive, referential, literary, and other modes. The course will also review rhetorical strategies for invention in the composing process: Burke's dramatic method, Rohman's prewriting, and Pike's tagmemics.

ENG 3385 Writing about Literature and Other Disciplines

This course will examine some characteristic student and professional writing in the humanities, sciences, and social sciences.

The goal of the course is to help participants see how students can use writing as a way of knowing and learning, not just in the English class but, for example, in the biology, history, or even mathematics class as well.

This course will focus on selected readings from relevant professional journals, popular magazines, and textbooks. Participants will analyze the content, style, and rhetorical method of these materials, as well as review writing tasks common to the disciplines.

ENG 3386 Research in Composition

The goal of this course is to prepare publication of research by providing a working knowledge of sources, current scholarship, and standards of publication. To this end, the course will acquaint participants with various bibliographies, journals, texts, and monographs that constitute the important documents of the field. Participants will use these documents to pursue research topics in invention, structure and form, modes of discourse, the composing process, and pedagogy.

ENG 3387 Case Study Design

This course will prepare participants for research to be conducted in Field Work during the academic year at the home institution. Participants will examine some published case studies of teaching and writings, and will explore relevant methods of data analysis, observation techniques, interview and questionnaire construction, sampling procedures, experimental design, and writing protocol analysis.

ENG 3388 Field Work

During the academic year, participants will conduct the independent research planned in Case Study Design.

The resources available for this research at the home institution will include the participants' individual teaching practices, course or departmental curriculum, the writing of their students and of students

in other classes, the practices of other teachers and administrators, as well as published books, reports, and articles on composition. They will collect, collate, and interpret data according to the guidelines established at the Institute. They will then prepare a project in which they present their findings.

ENG 3389 Case Study Analysis

Participants who have prepared Field Work projects will present their findings, draw their conclusions, and discuss the implications of their research for further study. Participants will be guided toward possible publication of their work in relevant composition journals.

This course concludes the Case Study Design, Field Work, and Case Study Analysis sequence.

ENG 3400 English Grammar

Methods and analytic procedures (but not the formalism) of modern linguistics are used to justify and support categories, distinctions, and structure used to describe sentences. These categories, distinctions, and structures will come mainly from the framework of traditional grammar. However, the inconsistencies and arbitrariness common in traditional grammar will be replaced by modern analyses, informally presented.

ENG 3401 Semantics

The relation between language and behavior; the concept of change, variety, and uniqueness; symbols, levels of abstraction, habits of evaluation of linguistic phenomena; representation of meaning in language.

ENG 3402 History of the English Language

Topics include the development of the sound system from Old English to the present; changes in the inflectional system and corresponding developments in sentence structure; processes of word formation and shifts in meaning. Poetry, prose, and nonfictional readings supplement the text.

ENG 3403 Topics in Linguistics

Subject to be announced.

ENG 3404 Language and Its Structure

Introduction to the study of language, the principles and methods of linguistic description; the development of the science of language, of descriptive and generative linguistics. Emphasis on goals of modern linguistic theory.

ENG 3405 Descriptive Linguistics

Intonation (stress, pitch, juncture); phonemics; morphemes and morphology; syntactic devices; the process of communication; variation in speech.

ENG 3406 Transformational and Generative Grammar of English

Deep and surface structures and transformations necessary to generate the latter; graphic representations of structure; deep-structure nature of adjectives, pronouns, prepositions, auxiliaries, possessives, comparison with traditional grammar.

ENG 3407 Children's Literature

A study of history and major forms of children's literature in the English language. The course covers such topics as folktales and folklore, novels, poetry, and informational books and includes cultural and sociological theories of childhood and adolescence.

ENG 3408 Literature and the Visual Arts

Examination of the complex relationships between literature and visual arts. Consideration of such topics as theoretical approaches to this relationship, the work of painter-poets, verbal descriptions of art (e.g., poems about paintings), works in which verbal and visual art are integrated. The course is organized by issues rather than historically. Each student is expected to work on an individual project. Field trips are included as part of the course.

ENG 3409 Literature and Psychology

An examination of theoretical positions and practical problems in the relationships between literature and psychology. Psychological interpretations of lyrics, works of fiction, and dramas are examined. In addition to the selected essays on certain literary works, several theoretical texts are studied.

ENG 3410 Short Fiction

The short stories of Sherwood Anderson and Ernest Hemingway and their contribution to American literature.

ENG 3411 Comic Drama

The Comic Spirit and its manifestations in dramatic literature and performance. The nature and forms of comic playwriting from Aristophanes to the present. An examination of the theater's comic forms: farce, comedy, satire, parody.

ENG 3412 Tragic Drama

This course considers important theories of tragedy and certain plays in an effort to consider the relation, if any, which exists between theory and practice of the tragic genre.

ENG 3414 Satire

A theoretical study of satiric forms—Roman, renaissance and neoclassical verse satire, and later satiric naratives. Writers surveyed can include Horace, Juvenal, Pope, Swift, Voltaire, Byron, Evelyn Waugh.

ENG 3415 Literary Impressionism

Intensive study of this theory of impressionism (with some attention to music and painting as well as literature) and its role in literary history. Readings explore French, British, Scandinavian, and American writers, especially Crane, Ford, Conrad, James, Moore, Hemingway, and Faulkner.

ENG 3416 Twentieth-Century British Drama

The course explores the evolution of British drama from Shaw to Tom Stoppard, giving particular attention to the influence of Ibsen and later European dramatists; the Irish influence of Yeats, Synge, and O'Casey; the traumas of two world wars; and the steady growth in the variety and power of British

dramatic productions. Among the writers to be studied, in addition to those already mentioned, are Arthur Wing Pinero, John Galsworthy, D.H. Lawrence, Samuel Beckett, James Osborne, Terrence Rattigan, and Harold Pinter.

ENG 3417 Topics in Twentieth-Century European Literature

Examination of such topics in continental literature of the period as literary movements (e.g. surrealism, modernism), major writers (e.g. Camus, Mann, Kafka), or genres (e.g. short fiction, drama).

ENG 3418 Topics in Twentieth-Century Literature

Examinations of such topics in world literature as regional literature (e.g. Latin-American writing, Japanese fiction), or literary movements (e.g. post-modern fiction).

ENG 3419 Topics in Genre

Examines such topics in genre criticism as biography, autobiography, epic poetry, lyric poetry.

ENG 3550 Classical Backgrounds

Readings in translation of Greek and Roman literature pertinent to the study of English and American literature. Focus upon the development of genre and theme.

ENG 3551 Chaucer's *Troilus and Criseyde*

A detailed examination of the poem.

ENG 3552 Chaucer's *Canterbury Tales*

Selected *Canterbury Tales*.

ENG 3553 Middle English Lyrics and Drama

A study of the epic and romance, concentrating on the transformation of the epic to the courtly hero: works to include in translation *Beowulf*, *Chretien de Troyes*, the *Nibelungenlied*, and *le Morte D'Arthur*.

ENG 3554 Studies in Fourteenth-Century Literature

Major works in non-Chaucerian Middle English including *Sir Gawain* and *The Green Knight*.

ENG 3555 Tudor Poetry

Wyatt and Surrey, Sidney, Marlowe, Spenser, Shakespeare: the poems of courtly love and the reaction against it.

ENG 3556 Renaissance Drama

Twelve representative Elizabethan and Jacobean comedies and tragedies.

ENG 3557 Shakespeare's Histories

The English history plays from *Richard III* to *Richard V*, plus *Titus Andronicus*, *Julius Caesar*, and *Troilus and Cressida*.

ENG 3558 Shakespeare's Tragedies

Eight plays from *Richard II* to *Antony and Cleopatra*.

ENG 3559 Shakespeare's Comedies

Eight plays from *Comedy of Errors* to *The Tempest*.

ENG 3560 Problems of Shakespearean Interpretation

A study of various "problematic" plays; a general knowledge of Shakespearean drama and the sonnets is presumed.

ENG 3561 Seventeenth-Century Literature

Major prose and poetry of the seventeenth century, excluding drama: Bacon, Hobbes, Browne, Bunyan, Donne, Herbert, Johnson, Marvell, and others.

ENG 3562 Milton's Major Poetry

Milton's poetic and intellectual achievement is studied through analysis of his major works. Particular emphasis is given to *Paradise Lost* as an expression of Renaissance humanism and the culmination to the epic tradition.

ENG 3563 Restoration and Early Eighteenth-Century Literature

A critical study of neoclassical drama, poetry, and criticism; Restoration drama, Dryden, Pope, Addison, Steele, and Gay.

ENG 3564 Age of Johnson

Johnson, Boswell, and the Club: Burke, Goldsmith, and Gibbon; poetry of Cowper, Gray, Burns, and Smart.

ENG 3565 Topics in Augustan Literature

Subject to be announced.

ENG 3566 Eighteenth-Century Fiction

Novels by Defoe, Fielding, Richardson, Smollett, Sterne, and Austen.

ENG 3567 Individual Eighteenth-Century Novelist

Subject to be announced.

ENG 3568 Romantic Poetry

A survey of representative forms and works of the major poets of the English Romantic Period (1798-1832): Blake, Wordsworth, Coleridge, Byron, Shelley, and Keats. The poetry will be studied in the historical and intellectual context of its time.

ENG 3569 Romantic Literature

A survey of representative forms and works of English Romantic prose—both fiction and nonfiction. Examples may be drawn from the fiction of Austen, Hogg, Scott, and the Gothic novelists, as well as from the nonfiction prose of Coleridge, De Quincey, Hazlitt, Lamb, and Shelley. Other texts may be used as needed to illustrate or amplify the ideas expressed in the prose.

ENG 3570 Topics in Romanticism

Romantic attitudes toward mankind in relation to self, society, and the universe, and Romantic attitudes toward the individual person as poet, with the impact these attitudes have upon the form and thematic substance of authentic and fictional autobiography in poetry and prose. May include an intensive reading of one major British writer whose attitudes, themes, style, and philosophy are representative of the Romantic Era (1794-1832).

ENG 3571 Victorian Literature

General survey touching upon major genres in Victorian literature with emphasis on the transition from the Victorian to the "modern," including such writers as Carlyle, Ruskin, the Brontes, Swinburne, Pater, Wilde.

ENG 3572 Victorian Poetry

A close study of Tennyson, Browning, Arnold; also the pre-Raphaelite circle and the movement toward modernism: D.G. Rossetti, Swinburne, G.M. Hopkins.

ENG 3573 Victorian Novel

Close study of major works by Dickens, Eliot, the Brontës, Hardy.

ENG 3575 Topics in Victorian Literature

Subject to be announced.

ENG 3577 Twentieth-Century British Poetry

The poets covered in this course will be drawn from among such names as Hardy, Yeats, Auden, Dylan Thomas, Ted Hughes, Philip Larkin.

ENG 3580 Twentieth-Century British Fiction

Major figures of the modern and the contemporary periods: Conrad, Joyce, Cary, Beckett, Braine, Fowles, Snow, Lawrence, Woolf, Murdoch, Lessing, Huxley.

ENG 3582 Topics in Irish Literature

Examination of such topics as the Irish Renaissance, Irish short fiction, the Irish novel.

ENG 3583 Early American Literature

A survey of American literature during its first two centuries, from the puritans to the Knickerbockers, from William Bradford to James Fenimore Cooper.

ENG 3585 Topics in Nineteenth-Century American Literature

Subject to be announced. Recent examples include: Transcendentalism, the literature of the Civil War, the literature of social reform.

ENG 3586 Nineteenth-Century American Prose, 1820-1865

This course will focus on the characteristics of the Romantic movement and New England Transcendentalism as we find them in the works of the principal prose writers of the period. The particular themes and techniques of such writers as Poe, Hawthorne, Melville, Emerson, and Thoreau will be determined by close readings of their texts.

ENG 3587 Nineteenth-Century American Poetry

Subject to be announced.

ENG 3589 Nineteenth-Century American Prose, 1865-1900

This course deals primarily with the post-Civil War novel in America, including the realistic and naturalistic movements, and such authors as Twain, Howells, and Henry James. It will also include some notable nonfiction writers, such as Henry Adams and William James.

ENG 3591 Modern American Poetry

Twentieth-century poets who have struggled to establish a tradition for American poetry and whose

examples have dominated poetry up to the present: Robinson, Frost, Stevens, W.C. Williams, M. Moore, Eliot, Pound, Crane, Cummings, and the Fugitives.

ENG 3592 Modern American Drama

Philosophic and aesthetic trends among such playwrights as O'Neill, Williams, Miller, Albee, Simon, and others.

ENG 3593 Individual Modern American Poet

Subject to be announced.

ENG 3594 Contemporary American Prose

Concentrates on the novel in exploring developments in American prose since 1945. Among writers likely to be considered are: Mailer, Bellow, Malamud, Barth, Heller, Walker, Pynchon, Vonnegut, and Hawkes.

ENG 3595 Individual Modern American Novelist

An in-depth examination of the work of a major figure in American fiction, focusing on the cultural context out of which he or she emerges. Recent selections for this course have been Hemingway, Fitzgerald, Mailer, Faulkner, and Bellow.

ENG 3596 Individual American Writer

Subject to be announced.

ENG 3597 Contemporary American Poetry

Subject to be announced.

ENG 3598 Modern American Prose

Includes close examination of such prose forms as the essay, short story, autobiography, biography, history, and novel. Writers may be selected with some special purpose in view, but are generally representative of the 1912-1950 period.

ENG 3600 Topics in Nineteenth-Century European Literature

Examination of such topics in continental literature of the period as literary movements (e.g. realism, decadence), major writers (e.g. Balzac, Flaubert, Dostoyevsky), or genres (e.g. novel, drama).

ENG 3601 Thesis

Six quarter-hours maximum; by arrangement.

ENG 3602 Independent Study

By arrangement.

ENG 3603 Independent Study—Certificate of Advanced Graduate Study

By arrangement. Limited to students in the Certificate of Advanced Graduate Study program.

ENG 3604 Independent Project, Technical and Professional Writing

Preparation of portfolio of technical and professional writing done for final project. Limited to students in Master of Technical and Professional Writing program.

History

All courses carry three quarter-hours of credit except seminars, which carry four quarter-hours, and other courses where noted.

HST 3241 Methodology

The objectives, methods, and resources of the historian.

HST 3242 European Historiography

The development of historical writing from ancient times to the present.

HST 3243 American Historians

The writing of American history by Americans, from colonial times to the present, with emphasis on changes in both form and substance.

HST 3301 Ancient Greece (Group I)

Selected topics in the history of ancient Greece.

HST 3302 Ancient Rome (Group I)

Selected topics in the history of Rome in the period of the Republic or the Empire.

HST 3306 The Renaissance (Group I)

European political and cultural life from the thirteenth to the seventeenth centuries, with attention to humanism and to the rebirth of classicism in literature and the arts.

HST 3307 The Reformation (Group I)

The development of the Christian Church from the thirteenth to the seventeenth centuries, with attention to the conflict between church and state, the impact of the Renaissance, the rise of the Protestant sects, and the wars of religion.

HST 3310 Intellectual History of Europe, 1688-1789 (Group I)

The broad spectrum of eighteenth-century thought, with emphasis on scientific, religious, and political ideas.

HST 3311 Intellectual History of Europe, 1789-1870 (Group I)

The great age of liberal and nationalistic thought. Social problems created by industrialism and various proposals to solve these problems are examined.

HST 3312 Intellectual History of Europe, 1870-1950 (Group I)

The intellectual developments which have brought Europe to its present position in world affairs. Topics considered include theories of evolution, scientism, radical socialism, and fascism.

HST 3315 Diplomatic History of Europe, 1815-1914 (Group I)

The foreign policies of the chief European powers, with emphasis on changing alliances and alignments, imperialistic rivalries, and efforts at international cooperation.

HST 3318 Imperialism (Group I)

The rise and development of colonial empires with emphasis on the 19th century. The nature of empire, motives for imperial expansion, and the colonial heritage.

HST 3320 Twentieth-Century Europe (Group I)

The political history of Europe since 1900, with attention to World War I, the rise of communism and fascism, the struggle for security in the western democracies, World War II, and the Cold War.

HST 3322 Socialism and Revolution (Group I)

Studies in the history of socialism and revolution from the early nineteenth-century utopias to the New Left of the 1960s.

HST 3330 Britain, 1688-1815 (Group I)

Topics include constitutional evolution, political parties, social and economic change, religious and intellectual developments, cultural achievements, and Scotland and Ireland.

HST 3331 Britain, 1815-1914 (Group I)

Aspects of nineteenth-century Britain, including reform of Parliament, liberalism and socialism, the Irish question, imperialism, and Victorian ideas and attitudes.

HST 3332 Britain since 1914 (Group I)

A social and political history with emphasis on the manner in which incompetent leadership and futile class struggle contributed to Britain's failure as a world power.

HST 3339 The Modernization of Ireland (Group I)

Analysis of themes in the growth and development of modern Ireland. Topics examined include migration and its effects on a traditional society, the role of religion in the assertion of national independence, and modernization within the British nexus.

HST 3345 Hitler's Germany (Group I)

A study of the history of the Third Reich, including an in-depth analysis of the process by which the political motives and methods of the Nazis ultimately won the support of the German people.

HST 3370 Family History (Group I or II)

An examination of the history of the family in Europe and America from the *ancien regime* to the present with attention to demographic issues and trends, industrialization and the family, women's roles, child-rearing practices, the changing nature of marriages and divorce, and life cycle and aging.

HST 3380 Seminar in the Renaissance (Group I)

Research and writing concerning the Renaissance.

HST 3381 Seminar in the Reformation (Group I)

Research and writing concerning the Reformation.

HST 3382 Seminar in European Intellectual History (Group I)

Research and writing on special topics in European intellectual history.

HST 3383 Seminar in Nineteenth-Century Europe (Group I)

Research and writing in European history from 1850 to 1900.

HST 3384 Seminar in Twentieth-Century Europe (Group I)

A study of a selected controversy in contemporary European history.

HST 3385 Seminar in European Social History (Group I)

Focusing on Britain, France, and Germany in the nineteenth and early-twentieth centuries and looking at history "from below," this course examines comparative issues in European social history. Topics include the nature of social protest, the rise of organized labor, and the impact of war and revolution on the lives of ordinary people.

HST 3386 Seminar in Imperialism (Group I)

An inquiry into the motives underlying European expansion in the late nineteenth century.

HST 3387 Seminar in Nineteenth-Century Britain (Group I)

Selected topics for research and writing with special emphasis on the social effects of industrialization.

HST 3388 Seminar in Twentieth-Century Britain (Group I)

Selected topics for research and writing.

HST 3389 Seminar in Modern France (Group I)

Research, writing, and collective analysis of several themes in modern French social history since 1789, including the role of social class in revolutionary protest, industrialization, technology and modernization, the rise of the working class and the development of organized labor, the French peasantry in an industrial society, the nature of the family, and women's roles.

HST 3390 Seminar in Russian History (Group I)

A narrow period or special topic in Russian history. *The course presupposes a basic knowledge of Russian history and requires extensive work on a research paper.*

HST 3397 Seminar in Comparative Labor History

Analysis of issues in the history of the European labor movement, focusing on nineteenth and twentieth century Britain, France, and Germany. Issues include: the meaning of the concept of class in labor history; labor movements and politics (working-class conservatism and working-class radicalism); the place of women in the working class and in the labor movement; worker responses to mechanization, automation and scientific management in the twentieth century.

HST 3399 Seminar in Approaches to Women's History (Groups I, II, or III)

Study focuses on current issues in women's history and the methods historians use to study women's historical roles in the market place, work force, political arena, and domestic scene in Europe, Asia, the United States, and Latin America. Emphasis is on the importance of comparative and interdisciplinary approaches to the history of women. The seminar includes lectures and discussions with special-

ists using various approaches, assigned reading, and an independent project.

HST 3404 Colonial America: The Seventeenth Century (Group II)

Exploration of the New World, settlement of the English North American mainland colonies, and the adaptation of European institutions and ideas to New World conditions.

HST 3405 Colonial America: The Eighteenth Century (Group II)

The expansion of the English colonies in the New World, the development of political and social institutions, and the sources of friction with England to 1763.

HST 3407 The American Revolution (Group II)

Topics in the history of the American Revolution from 1763 to 1783.

HST 3410 Topics in American Reform (Group II)

Selected studies of movements to change aspects of American society.

HST 3413 Topics in the Civil War and Reconstruction (Group II)

Analysis of key issues surrounding the events leading up to the Civil War, the war itself, and the Reconstruction period.

HST 3420 Public Life in Nineteenth-Century America (Group II)

Analysis of public policy and policy making; governmental structure, relations, and ideology; and electoral systems, viewed in long-run perspective.

HST 3421 Political Change in Twentieth-Century America (Group II)

Analysis of the growth of governmental function and structure, emphasizing the evolution and administration of leading policy concerns of the current century, changes in federalism and intergovernmental relations, and patterns of popular political participation and thinking.

HST 3423 The Age of Roosevelt (Group II)

An analysis of the foreign and domestic policies and programs of the four Roosevelt administrations, set within the context of the world-wide depression and global war. Emphasis is on the range of recent interpretations and analytic methods used in evaluating the place of Roosevelt in American history.

HST 3434 American Social History, 1900-1950 (Group II)

The transformation of the naive and idealistic America of the early twentieth century to life in a world in which technology has far outstripped man's mental and moral capacity to cope with it.

HST 3440 African-American History I (Group II)

The history of African-Americans to 1900, with emphasis on the role of black people in slavery and freedom.

HST 3441 African-American History II (Group II)

The history of African-Americans since 1900.

HST 3442 New Perspectives on American Slavery (Group II)

An in-depth examination of slavery in the Americas. Special emphasis will be placed on the impact of the slave trade; the development of slavery as an institution; the impact of slavery on the black family; the key role played by the black church; black resistance to slavery; the historiography of slavery, especially the two decades of reaction to the still-controversial thesis of Stanley Elkins; and slavery from a comparative perspective, contrasting slavery in Latin America and the United States.

HST 3450 Boston as a City (Group II)

An in-depth examination of historic Boston from 1822 to the present. Emphasis is on Boston's early growth as a city, the Hub as a center of pre-Civil War reform, the coming of the Irish, Boston as America's Athens, the revolutionary shift from Yankee to Irish political domination, the flamboyant era of James Michael Curley, and the development of the "New Boston."

HST 3480 Seminar in American History (Group II)

Research and writing on selected aspects of American history.

HST 3481 Seminar in Colonial and Revolutionary America (Group II)

Research and writing on some topic in American history prior to 1789.

HST 3482 Seminar in American Governmental History (Group II)

Concentrated attention to a particular problem or theme in American governmental history, emphasizing individual student research and writing.

HST 3483 Seminar in American Urban History (Group II)

The political, economic, and social history of America's major cities, with special emphasis on Boston's last century.

HST 3484 Seminar in American Maritime History (Group II)

Examination of selected aspects of American maritime history. Possible topics range from early exploration to the age of nuclear propulsion and may include merchant and naval aspects of the subject.

HST 3485 Seminar in African-American History (Group II)

Research and writing on an aspect of African-American history.

HST 3486 Seminar in Recent American History (Group II)

Special topics from the period 1896 to the present studied in detail. Students are expected to present a research paper on a major person, action, or movement.

HST 3501 History of Exploration (Group III)

A comprehensive survey of exploration from ancient times to the present with emphasis on the motives for exploration and their impact on the regions discovered and on those doing the discovering.

HST 3503 Approaches to World History (Group III)

An interdisciplinary examination of the study of civilization emphasizing various methodologies and theories and testing them by studying specific historical periods and cultures.

HST 3505 Canada and the United States (Group III)

How and why a separate Canadian nation managed to emerge despite decades of American political and military threats. Examination also includes Canada's subsequent response to growing cultural and economic domination by the United States.

HST 3508 Modern Africa (Group III)

A topical approach to the history of Africa since 1850.

HST 3509 Pan-Africanism (Group III)

Black political thought in Africa and the Americas during the nineteenth and twentieth centuries in the context of modern nationalism and capitalism.

HST 3510 History of the Islamic Peoples (Group III)

A study of the history, culture, and religion of the followers of Muhammad from 600 to 1800.

HST 3512 Modern Middle East (Group III)

A study of the Middle East in the twentieth century.

HST 3523 Modern Japan (Group III)

The history of Japan since the fall of the Tokugawa, emphasizing political and economic developments, especially after World War II.

HST 3529 Communism in China (Group III)

A study of the Chinese Communist movement from its origins in the 1920s to the present.

HST 3531 Population in History (Group III)

An application of demographic theory to history.

HST 3533 Psycho-History (Group III)

An introduction to the concepts, scholarship, problems, and directions of psychohistorical studies.

HST 3540 Economic History of the Modern Western World (Group III)

Topical analysis of the economic development of the modern Western world.

HST 3601 Historical Administration (Group III)

The administration of historical agencies with attention to problems of finance and personnel and to the legal-governmental environment in which agencies operate.

HST 3602 Historical Societies and Archives (Group III)

The varieties of historical societies (local, state, and national) and the kinds of private (business, college, church) and public (local, state, and national) archives; their activities and procedures; their similarities and differences.

HST 3603 Historical Exhibits and Museums (Group III)

Approaches, techniques, and special problems in the presentation of history to the public through exhibits, films, and other audiovisual and written media. Guest lecturers from the field present lectures, and students have the opportunity to gain practical experience.

HST 3605 Historical Editing (Group III)

A laboratory for the study and practice of historical editing. Students are introduced to the major collections of edited papers and instructed in editing historical documents. Each student is given an historical document to prepare for publication. Instruction also covers the editing of history books and journals.

HST 3610 Industrial Archeology (Group III)

An introduction to the history, practice, and place of industrial archeology. There will be examination of techniques and procedures used to unearth the industrial past. Field trips to local industrial sites will be taken.

HST 3611 Historic Preservation (Group III)

An introduction to historic preservation, with attention to the history, the philosophy, and the practical problems of preservation.

HST 3620 Oral History (Group III)

The theory and practice of creating, processing, and using primary source material obtained by taping interviews with people whose role in history would otherwise go unrecorded.

HST 3621 Genealogical Research: Methods and Uses (Group III)

An analysis of the tools and sources available to genealogists and historians with attention to historical applications of such data. Students will have opportunity to use various records essential to the writing of family history.

HST 3622 Local History Methodology (Group III)

An examination of the development and uses of local history with special attention to the methodological aspects of this burgeoning field. Publications of local

historical societies and museums will receive particular attention.

HST 3625 Media and History (Group III)

Students will have the opportunity to explore such topics as the advantages and drawbacks of specific media, the uses and abuses of media in research and teaching, and the construction of media. Each student is required to participate in a research project involving the creation and/or evaluation of historically valid films, slide tapes, and other materials.

HST 3805 Assigned Reading 1 Q.H.

Assigned reading under supervision of a faculty member.

HST 3806 Assigned Reading 2 Q.H.

Assigned reading under supervision of a faculty member.

HST 3807 Assigned Reading 3 Q.H.

Assigned reading under supervision of a faculty member.

HST 3811 Thesis 3 Q.H.

Thesis supervision by members of the department.

HST 3812 Thesis 3 Q.H.

Thesis supervision by members of the department.

HST 3813 Thesis 3 Q.H.

Thesis supervision by members of the department.

HST 3821 Fieldwork in History I 4 Q.H.

Fieldwork offers students the opportunity to get practical experience in historical agencies (including historical societies, archives, museums, exhibits, restorations, preservation projects, and the like). Students are required to work in the agency eight to ten hours a week for one quarter under the direction of an agency supervisor and departmental adviser.

HST 3822 Fieldwork in History II 4 Q.H.

A second opportunity for students to acquire practical experience in an historical agency. The fieldwork placement requires eight to ten hours a week for one quarter under the direction of an agency supervisor and a departmental adviser.

Law, Policy, and Society

Core Courses**ECN 3512 Introduction to Microeconomic Theory (Economics, 3 Q.H.)**

This course addresses the basic question of resource allocation within our society, a question central to issues concerning the appropriate role of government intervention in the private economy, the efficiency and equity of public expenditure-regulation programs, and the costs imposed on society by various activities that are unregulated or uncontrolled. This course is restricted to students in the Law, Policy and Society Program.

INT 3249, 3250 Law, Policy, and Society Survey (Interdisciplinary, 4 Q.H.)

This course is intended to offer students the opportunity to form a foundation derived from several disciplines in the range of methodologies and perspectives that are employed in the study of law and society. Among topics to be examined are issues such as normative vs. formative functions of law, social control vs. individual freedom, and legal bases of conflict management in society. Although the course is coordinated by one instructor, faculty affiliates of the program participate in the course, permitting approaches and specific content to be presented by

and discussed from a variety of informed perspectives.

LAW 2364 Legal Research and Bibliography (Law, 1 Q.H.)

This course is open only to students in the Law, Policy and Society Program. It is designed to introduce them to the resources and the use of the Law Library and the basic techniques of legal research.

SOC 3113 Introduction to Research Methods (Sociology, 2 Q.H.)

An introduction to methods of social research including field study and participant observation techniques.

survey techniques, interviewing and questionnaire construction, sampling procedures, experimental design, content analysis, and uses of available data. Open only to Law, Policy and Society students.

SOC 3114 Introduction to Quantitative Research Methods (Sociology, 2 Q.H.)

An introduction to quantitative techniques of analysis. Students are expected to conduct individual research projects. Open only to Law, Policy and Society students. *Prep.: SOC 3113 or its equivalent.*

Mathematics

MTH 3020 Basics of Analysis 2 Q.H.

Topology of metric spaces; Riemann integration; sequences and series of functions. (Coincides with undergraduate MTH 1312.) *Prereq.: MTH 1311 or equivalent.*

MTH 3101 Analysis I (Real Analysis) 4 Q.H.

Real analysis: integration, differentiation, measure theory. *Prereq.: MTH 3020 or equivalent.*

MTH 3102 Algebra I 4 Q.H.

Vector spaces, linear transformations and dimension. Eigenvectors, eigenvalues, and Jordan normal form. Determinants. Orthogonal and Hermitian matrices. The material would be developed in conjunction with, and supplemented by, applications selected from the following areas (or others chosen by the instructor). Finite element method in PDE's and mechanical engineering. Markov processes and generalizations from operations research. Control theory.

MTH 3103 Analysis II (Complex Analysis) 4 Q.H.

Complex function theory: holomorphic and meromorphic functions, calculus of residues, conformal mappings. *Prereq.: MTH 3020 or equivalent.*

MTH 3104 Algebra II (Groups & Rings) 4 Q.H.

Elementary Group Theory: definitions, computation in the symmetric group, finite groups, abelian groups, special groups. Elementary Ring Theory: definitions, integral domains, prime and maximal ideals, modules. Unique factorization. Representation of groups (group ring, characters). Applications: Fast Fourier transforms, coding theory, etc.

MTH 3105 Topology I 4 Q.H.

First part: elements of point set topology, including general topological spaces, compactness and connectedness, products and quotients. Second part: elements of algebraic topology, including homotopy, fundamental group and homology theory. (Balance of the two parts may vary with instructor.)

MTH 3106 Analysis III (Functional Analysis) 4 Q.H.

Topological linear spaces, normed and Banach spaces, linear functionals, weak topology, linear operators, Hilbert spaces. *Prereq.: MTH 3101.*

MTH 3107 Topology II 4 Q.H.

A continuation of MTH 3105. Homology, cohomology, duality on manifolds. Advanced topics in algebraic/differential topology as time permits.

MTH 3222 Applied Statistics 4 Q.H.

Level to measurement, central tendency, dispersion, relatedness and significance to differences, analysis of data through correlation, regression, F-test, Chi square tests, T-test, analysis of variance and analysis of covariance. These analyses are accomplished using computer-based statistical subroutine packages. *Not for math graduate credit.*

MTH 3224 Biostatistics 3 Q.H.

An introduction to the use of statistical techniques as applied to problems in the life sciences. Topics will include measures of central tendency and deviation, probability distributions, estimation and hypothesis testing, correlation and regression analysis and analysis of variance. Use of a computer statistical package such as Minitab. (Not for math graduate credit.)

MTH 3230 Introduction to Computer Programming and Applications 2 Q.H.

This course is designed to introduce graduate students in sciences, social sciences, and humanities to computer programming and to the role of the computer in solving problems in their areas of study. Students will learn to write and run programs in the language BASIC, and to use the computer for software packages related to various fields of endeavor. This course cannot be taken for credit by graduate students in the Mathematics Department.

MTH 3231 Introduction to Computer Programming and Applications 4 Q.H.

This course is intended for graduate students in sciences, social sciences, and humanities who need to understand how computers can help solve problems in their fields of study. After instruction in the basics of computer programming and algorithm development, students are introduced to examples of the computers used in different areas of human endeavor. Students are required to write programs in BASIC programming language and run them on a

computer. *This course cannot be taken for credit by graduate students in the Mathematics Department.*

MTH 3234 PASCAL 3 Q.H.

An introduction to PASCAL, emphasizing writing structured programs using loops, decision statements, procedures and functions. Data type will include integer, real, char, boolean and one- and two-dimensional arrays. Not for math graduate credit.

MTH 3302 Constructive Algebra 4 Q.H.

A constructive development of some of the old familiar areas of algebra: principal ideal domains, Dedekind domains, factorial domains, Noetherian rings.

MTH 3303 Set Theory 4 Q.H.

First part: Informal study of sets, including detailed discussion of the axiom of choice, well ordered sets, and transfinite arithmetic. Second part: versions of axiomatic set theory. The consistency of the continuum hypothesis and the axiom of choice. As time permits, the independence of the continuum hypothesis and the axiom of choice.

MTH 3305, MTH 3306 Philosophy 4 Q.H. each of Science and Mathematics I, II

Topics may vary from year to year. Past subjects have included the foundations of statistical inference, the structure of scientific theories, and analysis of the conceptual structure of mathematics.

MTH 3311 Mathematical Logic 4 Q.H.

Propositional calculus and quantificational logic; first order theories and their models; formal arithmetic and Gödel's First and Second Incompleteness Theorems.

MTH 3321 Algebra III (Fields) 4 Q.H.

Finite extensions of fields, automorphisms, structure of finite fields, normal and separable extensions, Galois group, Fundamental Theorem of Galois Theory, cyclotomic fields, solvability of equations by radicals. Applications (e.g. coding theory).

MTH 3331 Homological Algebra 4 Q.H.

Basic properties of categories and functors; sums, products, morphisms; Hom, Tensor product, and their derived functors Ext and Tor; exact sequences, homology and co-homology; homological dimension and co-dimension; applications to algebra and topology.

MTH 3332 Commutative Algebra 4 Q.H.

Prime ideals, localization, integral extensions; primary decomposition; Krull dimension; chain conditions, Noetherian and Artinian modules: additional topics from ring and module theory as time permits.

MTH 3341 Applied Mathematics I 4 Q.H.

Deterministic models in the physical and life sciences. Regular and singular perturbation: dimensional analysis; linear and nonlinear boundary layer problems; WKB theory; multiple scale analysis; qualitative analysis in phase science; singular perturbation of PDEs, asymptotic analysis.

MTH 3342 Applied Mathematics II 4 Q.H.

Introduction to dynamical systems, linear and nonlinear flows, closed orbits, asymptotic behavior and

stability. *Prereq.: MTH 3020 or equivalent and undergraduate differential equations.*

MTH 3351 Ordinary Differential Equations I 4 Q.H.

Existence and uniqueness of solutions, linear differential equations, nonlinear systems (stability, perturbations of periodic solutions, Poincaré-Bendixson). *Prereq.: Undergraduate differential equations.*

MTH 3353 Partial Differential Equations I 4 Q.H.

First-order quasilinear and general nonlinear equations: method of characteristics; second-order hyperbolic, elliptic, and parabolic equations: separation of variables, potential theory, and Fourier transform. *Prereq.: Undergraduate differential equations.*

MTH 3361 Numerical Analysis I 4 Q.H.

A rapid survey of the problems, issues, and techniques of numerical analysis. Problems considered include root finding, curve fitting, numerical integration, large linear systems of equations, ordinary differential equations. Issues considered include trade-offs, such as cost vs. precision and speed vs. space. Some programming will be done. *Prereq.: FORTRAN or PASCAL.*

MTH 3362 Numerical Analysis II 4 Q.H.

The numerical solution of partial differential equations, with emphasis on elliptic equations and the finite element method. *Prereq.: MTH 3361 or its equivalent.*

MTH 3371 Optimal Control Theory I 4 Q.H.

Linear and nonlinear control problems defined by ordinary differential equations, relaxed controls, existence theorems, Pontryagin's maximum principle.

MTH 3373 Optimization 4 Q.H.

Convex sets, linear and nonlinear programming, zero-sum games, dynamic programming, iterated methods.

MTH 3386 Lie Theory 4 Q.H.

Lie groups and Lie algebras. The exponential map. Examples, basic structure theorems. Representation theory. Applications. Additional topics vary with the instructor and may include infinite-dimensional Lie algebras, algebraic groups, finite groups of Lie type, geometry and analysis of homogenous spaces.

MTH 3400 Foundations of Geometry 4 Q.H.

Topics are: (1) Spaces on which geometry is done: Euclidean space, Riemann surfaces, differentiable manifolds, algebraic varieties. (2) Maps between manifolds: inverse and implicit Function theorems, Sard's theorem, transversality, singularities. (3) Invariants of manifolds and maps: degree and index. (4) Morse Theory: the relationship between manifolds and their differentiable functions. Application: classification of surfaces using Morse Theory. *Prereq.: Advanced calculus.*

MTH 3411 Differential Geometry 4 Q.H.

Geometry of surfaces in the euclidean space, with emphasis on the global aspects, using the technique of tensor calculus. Elements of Riemannian geometry, connections. Holonomy.

MTH 3414 Geometry and Mechanics 4 Q.H.
Hamiltonian and Lagrangian systems. Manifolds, differential forms, tensors and connections. Global structure of variational problems in higher dimensions.

MTH 3415 The Inverse Scattering Transform 4 Q.H.

The Schrödinger spectral problem on the line. Non-linear evolution equations solvable by the inverse scattering transform. Solitons. Bäcklund transformations.

MTH 3431 Probability I 4 Q.H.
Introduction to probability; independent random variables; types of convergence; laws of large numbers; characteristic functions, central limit theorem.

MTH 3432 Probability II 4 Q.H.
Introduction to stochastic processes; random walk; conditional expectations; Markov processes; multivariate normal distribution; Brownian motion.

MTH 3441 Statistics I 4 Q.H.
Parametric families of distributions; testing hypotheses; likelihood ratio tests; estimation and maximum likelihood, regression.

MTH 3443 Statistical Decision Theory 4 Q.H.
Subjective probability, utility. Bayesian approach to decision problems, including estimation, testing hypotheses, and linear statistical models. Sequential decisions. Admissibility.

MTH 3444 Analysis of Variance 4 Q.H.
One-sample and two-sample tests; one-way ANOVA; factorial and nested designs; Cochran's theorem; regression; analysis of covariance; simultaneous confidence intervals.

MTH 3445 Topics in Statistics 4 Q.H.
Topics to be selected from multivariate statistics and clustering; biostatistics; Stein's paradox and admissibility, foundations; probabilistic and inferential aspects of reliability theory.

MTH 3448 Nonparametric Methods in Statistics 4 Q.H.

This course presents methods for analyzing the data which is not necessarily normal. Topics emphasized include: comparing two treatments (the Wilcoxon test, Kolmogorov-Smirnov test), comparison of several treatments (the Kruskal-Wallis test), randomized complete blocks, tests of randomness and independence, asymptotic methods (the δ method, Pitman efficiency).

MTH 3450 Categorical Data Analysis 4 Q.H.
This course is primarily concerned with the analysis of data in tables, that is, with cross-classified data. Topics will include loglinear models (a generalization of analysis of variance methods) and logistic regression. Homework problems will sometimes involve the analysis of real data and will sometimes focus on theoretical issues.

MTH 3460 Pattern Recognition 4 Q.H.
An introduction to the methods of pattern recognition: multivariate normal distribution, linear discriminant analysis, logistic regression, tree structured classification, cluster analysis, jackknifing and bootstrapping, cross-validation. (This course is intended for students interested in computer science or applied statistics.)

MTH 3501 Data Structures 4 Q.H.
Basic structure for representing and manipulating data in computer programming: arrays, lists, stacks, queues, dequeues, trees, binary trees. Applications to nonnumeric computations. Searching and sorting. Students are required to write programs to implement these structures on a computer.

MTH 3502 Computer Organization and Assembly Programming 4 Q.H.

Computer organization; hardware and software components. Memory organization and addressing. Machine representation of data. Machine language and assembly programming. Subroutines and macros. Students are required to program several short exercises in assembly language and to undertake a term project at the end of the course.

MTH 3503 Compilers 4 Q.H.
Study of compilers; finite automata and lexical analysis; syntax specification; parsing; syntax-directed translation, symbol tables; run-time storage administration; error detection and recovery; code optimization, code generation. Students work as a team on a large programming project. *Prereq.: knowledge of assembly language programming and some knowledge of data structures.*

MTH 3514 Efficient Algorithms 4 Q.H.
We will discuss some of the recently discovered algorithms for evaluation of polynomials, string matching, generation of primes, roots of polynomials over finite fields, hash coding and finite Fourier Transform and its applications. *Prereq.: MTH 3535.*

MTH 3521 Theory of Automata and Formal Language 4 Q.H.

Finite-state machines and regular expressions, context-free grammars. Parsing of context-free languages. Context-sensitive grammars, push-down stores, stock machines, and linear-bounded automata. Turing machines, undecidability, description of computation using list-structures, program machines, and programs.

MTH 3522 Artificial Intelligence 4 Q.H.
Analysis of current computer programs dealing with problems such as theorem proving, chess playing, general problem solvers, robotics, symbolic computation, perceptions, self-reproducing automata, and parallel machines. *Prereq.: A course in data structures.*

MTH 3524 Discrete Mathematical Models 4 Q.H.
The course introduces the notion of mathematical model, develops mathematical models relevant to

problems in psychology, sociology, environmental science, political science, etc. The emphasis is on the use of discrete mathematical tools such as graph theory, Markov chains, game theory, etc.

MTH 3527 Combinatorics I (Enumeration) 4 Q.H.
Various techniques of enumerative combinatorics, including binomial and multinomial theorems, principle of inclusion-exclusion, recurrence relation, generating functions. Stirling numbers. Special topics such as distributions, partitions, and polycounting theory are also covered. Topics in Matching Theory, including Hall's theorem. Marriage Problem and Rado's Selection Principle.

MTH 3528 Combinatorics II 4 Q.H.
(Coding Theory & Block Designs)
Block designs, including t-designs, orthogonal Latin Squares, difference sets and finite geometries. Algebraic coding, including cyclic codes, Reed-Solomon Codes, BCH Codes, and Reed-Muller codes. *Prereq.: MTH 3102.*

MTH 3529 Graph Theory 4 Q.H.
Graphs and subgraphs; trees; connectivity; Euler tours and Hamilton cycles; matchings, edge colorings; independent sets and cliques; vertex colorings; planar graphs; directed graphs; networks, the cycle space and bond space.

MTH 3530 Topics in Combinatorics 4 Q.H.
Topics in combinatorics will be offered in a different subspecialty each time. Topics will be chosen from: game theory, combinatorial geometry, measurement, algebraic combinatorics, etc.

MTH 3535 Algorithms and Complexity 4 Q.H.
Theory
Complexity of algorithms, kinds of complexity; intractable problems, including NP-complete and NP-hard problems; approximation algorithms and local search; parallel processing and randomized algorithms.

MTH 3801 Seminar: Constructive Mathematics 4 Q.H. per quarter

MTH 3806 Readings in Algebra 4 Q.H. per quarter

MTH 3807 Seminar in Algebra 4 Q.H. per quarter

MTH 3811 Readings in Analysis 4 Q.H. per quarter

MTH 3812 Seminar in Analysis 4 Q.H. per quarter

MTH 3818 Seminar: Dynamical Systems 4 Q.H. per quarter

MTH 3821 Readings in Topology 4 Q.H. per quarter

MTH 3822 Seminar in Topology 4 Q.H. per quarter

MTH 3826 Readings in Statistics and Probability 4 Q.H. per quarter

MTH 3827 Seminar in Statistics 4 Q.H. per quarter

MTH 3836 Seminar in Combinatorics 4 Q.H. per quarter

The department offers an assortment of courses under the general heading "Seminar" (MTH 3812-9). At the outset of each quarter, times for organizational meetings will be posted. Schedule and content are negotiated at these meetings. Students and faculty with interest in the specialty of the seminar are encouraged to attend the organizational meeting.

MTH 3850 Doctoral Dissertation
Students may take graduate courses in the Computer Science College as required electives with permission of their advisor.

Physics

I. Introductory Courses

PHY 1305 Thermodynamics and Kinetic Theory 3 Q.H.

Topics include first and second laws of thermodynamics; entropy and equilibrium; thermodynamic potentials; elementary kinetic theory; statistical mechanics and the statistical interpretation of entropy.

PHY 1413 Introduction to Nuclear Physics 3 Q.H.
Topics include nuclear structure; nuclear masses; radioactivity-nuclear radiation; interaction of radiation and matter; detectors; fission, nuclear forces; elementary particles. *Prereq.: PHY 1303 or equiv.*

PHY 1414 Introduction to Solid State Physics 3 Q.H.

This course offers a semiclassical treatment of the thermal, magnetic, and electrical properties of crystalline solids. Topics include X-ray diffraction and the reciprocal lattice; elasticity and lattice vibrations; specific heat; properties of insulators; magnetism in insulators and metals; introduction to the band theory of metals; *Prereq.: 1 PHY 1305 and PHY 1303 or equiv.*

PHY 1415 Quantum Mechanics I 3 Q.H.
The first of a two-quarter sequence in quantum mechanics, this course focuses on observations of

macroscopic and microscopic bodies, the uncertainty principle—wave-particle duality; probability amplitudes; Schrodinger wave theory; one-dimensional problems. *Prereq.: PHY 1303 or equiv.*

PHY 1416 Quantum Mechanics II 3 Q.H.

A continuation of PHY 1415, this course covers discrete and continuous states; Schrodinger equation in three dimensions; angular momentum; general theory of quantum mechanics; applications. *Prereq.: PHY 1415.*

PHY 3401 Radiation Physics 2 Q.H.

Introduction to atomic and nuclear physics for graduate students in biology and pharmacy. Topics include quantum mechanics and atomic structure, nuclear structure, radioactivity, properties of nuclear radiation, detection of radiation.

PHY 3402 Radiation Biology 2 Q.H.

The effects of radiation on biological systems and the uses of radiation in medicine and biological research. Topics selected from effects of radiation on chemical reactions; effects of radiation on cells, organs, and individuals; theories of radiation damage and repair; imaging and tracer techniques using radiopharmaceuticals; radiation safety and standards. *Prereq.: PHY 3401 or equiv.*

PHY 3551, PHY 3552 Electronics for Scientists I, II 4 Q.H.

PHY 3551 and PHY 3552 form a two-quarter sequence covering electronic techniques for experiments research in many different fields of science. Topics include principles of semiconductor devices; analog techniques (amplification, feedback, integration), digital techniques (counting, multiplexing, logic); design of electronic subsystems (analog-to-digital converters, phase-sensitive detectors, data-logging systems); understanding specifications of commercial electronic equipment. Lab examples make use of up-to-date integrated and discrete devices, such as are currently used in the electronic industry.

II. Required Regular Courses (offered every year)

PHY 3557 Graduate Advanced Laboratory 4 Q.H.

This course presents special projects in modern experimental physics, including electronic instrumentation used in measuring physical quantities and use of microprocessors. *Prereq.: PHY 3551 and 3552 or permission of instructor.*

PHY 3561 Graduate Project Laboratory 4 Q.H.

This course allows students to select and carry out individual projects involving instrumentation and computation. The projects involve the development of some aspect of instrumentation and/or computation in an ongoing research project, and the preparation of a final report. The student will be supervised by the project leader and the course instructor. Although the course carries 4 q.h. credit, it is taken in successive winter and spring quarters. *Prereq.: Permission of instructor.*

PHY 3601, PHY 3602 Mathematical Methods A, B 4 Q.H.

Calculus of variations. Euler-Lagrange equations. Mathematical methods in physics. Topics from theory of function of a complex variable. Analytic functions. Taylor and Laurent series. Analytic continuation and classification of functions. Calculus of residues. Asymptotic series. Dispersion relations. Applications to ordinary differential equations and the study of special functions. Finite and infinite dimensional vector spaces. Linear operators. Function spaces and generalized Fourier expansions. Green's functions and integral equations. Introduction to group theory.

PHY 3603 Classical Mechanics 4 Q.H.

Generalized coordinates and Lagrangian formulation of mechanics, conservation laws. One-dimensional and central force problems. Collision theory. Rigid bodies. Hamiltonian formulation and the canonical formalism. Continuous systems and classical fields.

PHY 3611, PHY 3612, PHY 3613 3 Q.H.
Electromagnetic Theory A, B, C

Maxwell's equations. Static field and boundary value problems, multipole expansion. Phenomenology of dielectrics, conductors, and magnetic materials. Faraday's Law. Energy and momentum; Poynting vector; Maxwell stress tensor. Plane waves, polarization. Reflection and refraction; diffraction. Relativity Radiation from sources. Motion of charged particles in electromagnetic fields; magnetic mirrors, particle accelerators. Introduction to plasma physics; magnetohydrodynamics. Radiation from accelerated charges; bremsstrahlung, synchrotron radiation. Scattering of radiation; interaction of radiation with matter. *Prereq.: PHY 1403, PHY 3601 (concurrently).*

PHY 3621, PHY 3622, PHY 3623 4 Q.H.
Quantum Theory A, B, C

Experimental basis of quantum theory. Schrodinger equation and probability interpretation of wave mechanics. Uncertainty principle. Application to one-dimensional problems, the harmonic oscillator, orbital angular momentum, and the central force problem. Quantum theory of scattering. Born approximation. Phase-shift analysis, introduction to S-matrix theory. General formulation of quantum mechanics in Hilbert space. Spin. Identical particles and symmetrization principle. Time-independent and time-dependent perturbation theory. Semiclassical theory of radiation and atomic spectra. Addition of angular momentum. Wigner-Eckart theorem. Quantum theory of radiation. Absorption, emission, and scattering of photons. *Prereq.: PHY 1415 or equiv.*

PHY 3624 Advanced Quantum Theory 4 Q.H.

Introduction to the formulation of a relativistic quantum theory. Study of the Dirac equation and its Lorentz covariance. Plane-wave solution of the Dirac equation, and projection operators. Bound-state solutions of the Dirac equation in a Coulomb field and the hydrogen atom. Parity, charge conjugation, and time-reversal symmetries. Propagator theory. *Prereq.: PHY 3623.*

PHY 3631 Statistical Physics A 3 Q.H.
The phenomenological theory of thermodynamics. Fundamental relations and thermodynamic potentials. Extremal principles of thermodynamics. Applications to simple systems. Stability conditions. Phase transitions. Thermodynamics of electric and magnetic systems. Principles of irreversible thermodynamics. *Prereq.: PHY 3603 and PHY 3621 (concurrently).*

PHY 3632, PHY 3633 Statistical Physics B, C 3 Q.H.
The principles of statistical mechanics and statistical thermodynamics. Density matrix. Theory of ensembles. Derivation of the laws of thermodynamics. Fermi-Dirac and Bose-Einstein statistics. Application to gases, liquids, and solids. Theory of phase transitions. Second-quantization formalism for interacting systems. Cooperative phenomena. *Prereq.: PHY 3631, PHY 3621.*

PHY 3641, PHY 3642 Solid State Physics 4 Q.H.
The course covers topics from Drude and Sommerfeld (or free electron) models of electrons in metals, crystal structure, one-electron states in crystal lattices, Bloch's Theorem, semiconductors and semiconducting devices, effects of electron-electron interactions, lattice vibrations and the classical and quantum theories of specific heat, optical properties of solids, investigation of crystal structure and excited states of crystals by X-ray and neutron scattering, simple transport theory based on the Boltzmann equation, magnetic properties of solids.

III. Advanced Electives

PHY 3643, PHY 3644, PHY 3645 4 Q.H.
Advanced Solid State Physics A, B, C
Selected advanced topics in the theory of solids to be chosen each time by the interested students and instructor. For example, theory of normal metals, Hartree-Fock and Random phase approximations, optical and transport properties, solid-state plasmas, Raman spectroscopy, quasiparticles and collective excitations, quantum solids, amorphous solids. *Prereq.: PHY 3633, PHY 3623, PHY 3642.*

PHY 3653, PHY 3654, PHY 3655 Fields, Particles, and Currents A, B, C 4 Q.H.
Introduction to a local field theory. Symmetries of the Lagrangian and conservation laws. Lorentz group, spin and helicity. P, C, and T. Klein-Gordon, Dirac, vector meson, photon and non-Abelian gauge fields. Gauge theories; Feynman path integral formulation. The S-matrix and LSZ reduction formulae. Spectral representations. Feynman diagrams. Green's functions at large Euclidean momenta. Renormalization and finiteness. Quantum chromodynamics. The renormalization group and asymptotic freedom. Spontaneous breaking and Higgs phenomenon. Glashow-Salam-Weinberg unified theory of weak and electromagnetic interactions. *Prereq.: PHY 3624*

PHY 3661, PHY 3662, PHY 3663 4 Q.H.
Many-Body Theory A, B, C 4 Q.H.
Introduction to some many-body problems and the required mathematical techniques. Theory of linear response and correlation functions. Landau's theory of Fermi liquids and applications to solids. Theory of superconductivity and superfluidity. General theory of Green's functions and diagrammatic techniques. *Prereq.: PHY 3633, PHY 3623, PHY 3642.*

PHY 3671 Foundations of General Relativity 4 Q.H.
The course discusses the physical basis underlying relativity (the weak and strong principle of equivalence), the role of the metric tensor as a carrier of gravitational information, and the modification of the Lorentz covariant field equations in the presence of gravitation. An introduction to Riemannian geometry is given, and the Einstein field equations and tests of Einstein's theory are discussed. *Prereq.: PHY 3672, PHY 3603, PHY 3613, and PHY 3623.*

PHY 3672 Relativistic Astrophysics and Cosmology 4 4 Q.H.
The course deals with the equations for the relativistic stellar system, white dwarfs, neutron stars and properties of pulsars, gravitational collapse and black holes, quantum radiation from black holes, super heavy stars as possible quasar energy sources, quantum effect in gravitational collapse, the metric for cosmological systems, and the big bang theory. *Prereq.: PHY 3671 and PHY 3624.*

PHY 3673 Quantum Gravity 4 Q.H.
The course deals with gravitation as a quantum field, threshold properties of gravitational quantum S-matrix, quantization leading to a set of Feynman rules, calculations of simple tree diagrams, closed loop infinities and the problem of renormalizability of quantum gravity. *Prereq.: PHY 3672*

PHY 3798 Master's Thesis Continuation 0 Q.H.
PHY 3799 Doctoral Dissertation Continuation 0 Q.H.

PHY 3811, PHY 3812, PHY 3813 Reading Course 1 Q.H.

PHY 3821, PHY 3822, PHY 3823 Reading Course 2 Q.H.

PHY 3831, PHY 3832, PHY 3833 Reading Course 3 Q.H.

PHY 3841, PHY 3842, PHY 3843 4 Q.H.
Reading course, or theoretical or experimental work under individual faculty supervision. *Prereq.: Consent of faculty member.*

PHY 3895 Doctoral Dissertation
Experimental and theoretical work for Ph.D. candidates.

Political Science

All courses carry three quarter-hours of credit unless otherwise specified. Most courses are seminars.

ECN 3111 Economics for Public Administrators

Introduction to basic economic concepts essential to other courses in the program. This course is a prerequisite for students lacking economic course work at the baccalaureate level.

POL 3500 Scope and Methods of Political Science

This course is designed as an in-depth examination of the assumptions, principles, etc., that underlie contemporary political science. As such, it invites the student to consider the present practice of the discipline in the light of its history and to critically evaluate the discipline in the interest of a greater understanding of nature and limits.

POL 3502 Seminar in American Government

This course analyzes the institutions of the national government in the United States, focusing on the executive, legislative, and judicial branches. Political parties and pressure groups are also examined, as is the American constitutional system. *M.P.A. elective.*

POL 3504 Political Psychology and Socialization

An examination of theories of political psychology, opinion formation, and attitude change; of political ideology; of processes of individual political development and socialization; of effects on mass and elite political behavior; of attitudinal differences and differential socialization experiences; of individual political behavior and the political system.

POL 3506 Politics and the Mass Media

Study of the role of mass media in the formation of public opinion, with special attention given to media usage in the electoral process.

POL 3508 Legislative Process

Study of Congress and of the influence of the President, administrative bureaucracy, parties, interest groups, and public opinion on the development of legislative policy. Comparisons are made with legislative process in the states. *M.P.A. elective.*

POL 3510 Theories of American Political Participation

This course focuses on political behavior at both the national electorate level and at the level of legislative roll-call voting, analyzing the relative impact of demographic and attitudinal components as well as the effect of constituency and partisan identification upon legislative behavior.

POL 3512 American Constitutional Law I

Employing excerpts of U.S. Supreme Court decisions and other primary legal materials, this course examines the constitutional rationale for judicial review; various philosophical approaches to the exercise of judicial power; and the scope of judicial authority to settle questions challenging the legitimacy of governmental actions in the American constitutional system.

POL 3514 American Constitutional Law II

Using excerpts of primary legal materials, this course builds upon the judicial doctrines developed in POL 3512 and specifically examines the constitutional theories behind the growth of congressional prerogatives in economic and social affairs and expanding presidential power in internal and foreign matters. *Prereq.: POL 3512 or consent of the instructor.*

POL 3516 The Presidency

An analytic treatment of the constitutional and extraconstitutional powers of the contemporary president, an examination of the place and function of the chief executive in the formulation and execution of public policy. *M.P.A. elective.*

POL 3518 American Electoral Behavior

The theoretical and methodological assumptions of election studies of the American political system are analyzed and the substantive conclusions carefully reviewed.

POL 3519 Campaigns and Elections

A study of campaign tactics and strategies. *Field Work required.*

POL 3520 The Judiciary

Analysis of the role of the judiciary in the American governmental process. Special attention is given to those areas of constitutional law in which the courts' decisions have a profound impact on the basic structure of American politics (apportionment, economic regulation, federalism, etc.).

POL 3522 Political Parties, Pressure Groups, and Public Policy

A study of the role of parties and pressure groups in the policy-making process, trends in contemporary party politics are examined as well as behavior patterns of the American electorate.

POL 3524 Civil Rights

Examination of the doctrine of constitutionalism, illustrated and amplified by a study of the substance and process of the Bill of Rights as developed in decisions of federal courts, and congressional enactments.

POL 3526 Procedural Due Process

Utilizing excerpts from U.S. Supreme Court decisions and other legal materials, this course examines the philosophical and constitutional relationships between Amendments 4, 5, 6, and 8 and the Fourteenth Amendment. The substance of the right to fair trial, counsel, confrontation, protection against self-incrimination, and unreasonable searches and seizures are among the many procedural rights examined through the decisions of the Roosevelt, Vinson, Warren, and Burger Courts.

POL 3531 Models of Political Systems

A detailed examination and critique of current models of political systems.

POL 3533 Eurocommunism

A study of the ideology and political behavior of the communist parties of Italy, France, and Spain, with emphasis on their independence of, and challenges to, the domestic and foreign policies of the Soviet Communist Party.

POL 3535 Parliamentary Democracy in Western Europe

A comparative analysis of environment, vehicles of popular participation, and formal structures and reach of government in the parliamentary democracies of western Europe. Special attention is given to England, France and Germany.

POL 3537 Comparative Communism

A comparative analysis of environment, vehicles of popular participation, and formal structures and reach of government in the Soviet Union, the socialist countries of eastern Europe, and China.

POL 3539 European Political Parties

A comparative cross-national study of political organization and behavior in England, France, and Germany with emphasis on party leadership, strategy, organization, and constituency as well as socialization, recruitment, and participation of voters.

POL 3541 European Legislative Systems

A comparative analysis of the legislatures in Britain, France, and Germany with emphasis on patterns of historical development, functions, internal organizations, and relations with the executive.

POL 3543 European National Executives

A comparative cross-national study of executive decision making in England, France, and Germany with emphasis on varying patterns of presidential and cabinet authority as well as relationships with the legislature.

POL 3545 Government and Politics in the Middle East

This course examines the political and economic structures of the Arab states and Israel as well as inter-Arab politics and inter-state conflict in the area.

POL 3547 Government and Politics of North Africa and the Middle East

Comparative analysis of the political systems and foreign policies of African states north of the Sahara. Also stressed is the relationship of this area with the Middle East.

POL 3550 Government and Politics of the United Kingdom of Great Britain and Northern Ireland

An analysis of government organization and political behavior in the United Kingdom. Special attention is given to executive-legislative relations, the political party system, and the politics of Northern Ireland.

POL 3551 Seminar in International Relations

An in-depth analysis of the major actors, their goals, and the means and strategies they utilize within the international system.

POL 3552 International Political Economy

The course explores new directions in the field of international political economy. Stress is laid on approaches to and trends within the field, such as 1) the intellectual and theoretical roots of international political economy; 2) the management of collective goods; 3) relations between advanced industrial states; 4) relations between advanced industrial and less industrial states; 5) relations between nonstate and state actors.

POL 3553 Government and Politics in Germany

A study of political culture, federalism, and executive-legislative relations on the national level with a view to appraising the quality and durability of the present democratic system.

POL 3554 Government and Politics of France

A study of current governmental organization and political behavior in France. Special attention is given to the role of the presidency, executive-legislative relations, and the political party system.

POL 3555 International Organization

This course focuses on issues of international political economy. The role of various international organizations in managing economic interdependence is emphasized. Attention is given also to the role of international administrators in the UN's search for a new international economic order. Discussion of nongovernmental organizations, such as multinational corporations, is included.

POL 3556 China in Revolution

Addresses the problems faced by a revolutionary China in forming new attitudes, instituting a revolutionary political culture, and reconstructing and developing a country on the basis of a revolutionary ideology. Illustration of the manner in which the party, state, military, education, health, science, and medicine have been modified since 1949 to ensure the continuation of a revolutionary polity.

POL 3557 Soviet-Chinese Relations

A chronological and topical analysis of the Soviet-Chinese relationship since 1950 with special attention to the causes of rivalry and conflict in the 1960s and 1970s.

POL 3558 Asia and the Politics of Development

This course relates the theoretical literature on political development to the concrete attempts to develop in Asia. Because of the diversity in levels and types of political development in Asian states, each student is encouraged to concentrate on one state and explore different ideas about political development as they relate to that state.

POL 3559 Governments and Politics of Latin America

This course investigates contemporary Latin American politics with particular emphasis on revolution, development strategies, and social change. Focus is on three representative nations such as Mexico, Chile, and Cuba.

POL 3560 Development Politics

The process of political development in the Third World, including both internal and international issues such as leadership patterns, the role of the military and political parties, and underlying economic and social factors.

POL 3561 Great Powers and the Middle East

An analysis of the changing nature of great power and multinational involvement in the Middle East.

POL 3562 United States-Soviet Relations

The relations between the United States and the Soviet Union from 1917 to the present. Topics stressed are the "nonrecognition" period, the breakdown of the World War II "Grand Alliance," and the nature of the present power conflict.

POL 3563 United States-Far Eastern Relations

American diplomacy in the Far East, with primary concentration on relations with Japan since World War II, with China, and with Southeast Asia.

POL 3564 China's Foreign Policy

A study of the Chinese government's relations with the Third World socialist states and the West and its behavior in the United Nations. Analyzes changing policies toward international law, trade, tourism, scholarly exchange, and foreign ventures in China. Attention is given to policy objectives strategy, tactics, and the method of decision making in the foreign policy apparatus.

POL 3565 Soviet Relations with Eastern Europe

An analysis of Soviet policy in Eastern Europe, especially Russian efforts after World War II to develop communism and maintain a position of preeminence in this region.

POL 3566 Chinese Politics

Concentrates on the objectives of the Chinese revolution from 1911 to the present. Examines the political theory and institutions which have been established to promote "permanent revolution" and evaluates the nationality of Chinese communist policies in terms of Chinese goals. Concentrates on the changes made in domestic, economic, legal, and political policies since 1976.

POL 3567 Japanese Politics

Designed for students in both comparative politics and in international relations, the course examines the unique Japanese electoral system, political processes and organizations, political culture and socialization, the role of business in politics, and Japanese foreign policy.

POL 3568 Sub-Saharan African Politics

Comparative analysis of the political systems and foreign policies of selected African states south of the Sahara. Special attention is given to the Republic of South Africa and its policy of apartheid.

POL 3569 Decision Making in U.S. Foreign Policy

Comprehensive analysis of the governmental mechanism and process for decision making in U.S. foreign policy. Case studies in decision making are emphasized.

POL 3570 American Foreign Policy

Examination in depth of selected issues concerning the role of the United States in world affairs since 1945.

POL 3572 Problems of World Order I

Emphasizes such topics as appraisal of diverse systems of public order, approaches of international law and international organization to the problem of world order, and the problem of world peace enforcement.

POL 3573 Problems of World Order II

Political problems of world order are stressed. Representative topics include arms control and disarmament, the limits of economic growth, international political economy, population problems, and resource distribution.

POL 3574 American National Security Policy

This course deals with United States national security policy in the post-World War II era. The focus is on the evolution of U.S. nuclear and conventional strategy and arms control efforts. Future military and arms control options will also be considered.

POL 3575 Arab-Israeli Dispute

The Arab-Israeli confrontation has its own dynamics and a character that has changed through the decades. This course analyzes its interaction with the internal politics of the Arab states and Israel, pan-Arab politics, and the role of the great powers in the region.

POL 3578 Soviet Foreign Policy

A study of Soviet foreign policy since 1964. Among the topics discussed are detente in relations with the United States; polycentrism in East Europe; involvements and commitments in the Middle East and Africa; and the dispute with China.

POL 3580 The United Nations

Selected topics on the nonpolitical work of the United Nations: human rights; economic, social, health and related problems; decolonization and the trusteeship system.

POL 3581 International Peacekeeping

A detailed investigation of the origins, history, and theory of interventionary peacekeeping, with reference to the documentation of the United Nations. An assessment of this method of maintaining regional stability and a projection of potential means of developing the method to broader applicability.

POL 3583 International Law

Examination of selected topics in international law not covered in POL 3572 and POL 3573.

POL 3584 Regional Organizations

Regional organizations, such as EEC or OAU, are studied to determine the capability of such organizations to promote economic development and political influence.

POL 3585 The Atlantic Community

A topical analysis of European-American diplomacy with particular stress upon security and economic

matters. Major consideration of the integration of Europe, American responses, and the results of these interactions for world political and economic stability.

POL 3586 Nationalism

The evolution and role of nationalism in both theory and practice. Representative nationalistic movements and theories are analyzed.

POL 3587 Politics of Revolution and Change

Analysis of the nature of political change with attention to both theory and practice. Topics discussed are revolution, major trends in contemporary politics, and the relationship between political change and technological, scientific, or social change.

POL 3589 Terrorism, Violence and Politics

Analysis of the theory and practice of terror, violence, coercion, force, and threats in political life.

POL 3590 Crisis Politics In Democracies and Dictatorships

Analysis of governmental response to crises and emergencies. Consideration of such topics as war powers, riot and rebellions, martial law, transfer of regime, succession problems, economic crises, presidential emergency powers, national security powers, executive privilege, and impeachment.

POL 3591 Totalitarianism

An analysis of totalitarianism and dictatorship, including study of historical background, fundamental characteristics; theories of origin, nature, and significance; and evaluation of techniques, ideologies, policies, and instruments of power. Special attention is given to the government and politics of the Soviet Union.

POL 3593 Ancient and Medieval Political Thought

The development of political thought from Greek antiquity to the end of the Middle Ages, utilizing both historical and analytical approaches. Attention is also paid to the cultural, social, and intellectual context within which political theories develop.

POL 3594 Modern Political Thought

Examination of political thought from Machiavelli to Marx.

POL 3595 Contemporary Political Theory

The main currents of political thought in the latter half of the nineteenth and the twentieth centuries with special emphasis on the relations between political theory philosophy and political science.

POL 3596 Marxism

Examination of the theory and practice of Marxism, including its background and origins, and its subsequent development.

POL 3597 Trends in American Political Thought

Examination of intellectual concepts and movements that have informed and influenced American political life, with emphasis upon those relating to the making and execution of public policy. *M.P.A. elective.*

POL 3600 Survey of Public Administration

Introduction to the literature and the major topics in public administration with special attention given to

the interrelationships of politics and administration. *M.P.A. core course.*

POL 3601 Public Personnel Administration

Technique, practice, and organization of personnel functions in public administration, including recruitment, compensation, training, discipline, and relations with employee organizations. *M.P.A. core course.*

POL 3602 Organization Theory and Management

An in-depth study of the major organization theories, including the scientific basis for organization theory; models and ideal types; decision making; application of game theory, systems analysis. *M.P.A. core course.*

POL 3603 Public Finance and Budgeting

Emphasizes the public budgeting function in its relationship to other functions of public administration. The subject is approached from a management perspective, and conflicting legislative and executive finance and budgeting interests are examined. Also included is an illustration of the budget cycle and an examination of the mechanics of budget preparation. Attention is given to means for improving budget decision making and administration through quantitative and other methods. *M.P.A. core course.*

POL 3604 Techniques of Policy Analysis

Focuses on the various techniques useful in analyzing public policy issues. Case studies of specific applications of such methods as modeling, simulation, and survey research are examined. *M.P.A. elective.*

POL 3605 Quantitative Techniques for Public Administrators I

A consideration of the theory and process of administrative study including philosophy of science, quantitative and qualitative designs and methods of problem solving, and drawing causal principles. *M.P.A. core course.*

POL 3606 Quantitative Techniques for Public Administrators II

The application of social science research and computer programming to administrative problems, including techniques for analysis of survey and other data and practical methods of gathering, analyzing, and presenting such data. *M.P.A. core course.*

POL 3607 Quantitative Techniques III: Computer Applications

A continuation of the study of quantitative techniques, with particular emphasis on various computer usages for public managers.

POL 3610 Methods of Economic Analysis for Public Administrators

A central concern of this course is to introduce a construct of public economy as a means for focusing on contemporary issues facing public administrators. Both the concepts and applications of economic analysis are presented to offer the student a new analytical tool for evaluating public policy, implementation, and impacts on the citizenry. *M.P.A. elective.*

POL 3611 Intergovernmental Relations

An institutional-behavioral analysis of the changing relationship among the various levels of American government—national, state, and local—relating the pattern of change to the social and economic forces which underlie it. *M.P.A. elective.*

POL 3613 Constitutional Law in Public Administration

An introduction to American constitutional law and the federal system using case materials and emphasizing principles of importance to public administrators, including such constitutional concepts as separation of powers, judicial review, dual federalism, legislative investigating power, executive impoundment, federal preemption, and the appointment and removal power. *M.P.A. elective.*

POL 3614 Administrative Ethics in Public Management

An analysis of ethical problems in American public administration including discussion of ethical dilemmas frequently faced by public managers. *M.P.A. elective.*

POL 3615 Development Administration

This course takes a "manager's-eye view" of the formulation, implementation, evaluation and improvement of development projects in less developed countries. Topics include integrated rural development, community participation, lower- and middle-level management decentralization and management training. *M.P.A. elective.*

POL 3616 State Government

Appraisal of the problems of contemporary state government in the United States. Particular emphasis is given to the state government of Massachusetts. Individual research is stressed. *M.P.A. elective.*

POL 3617 Industrial Policy

Industrial Policy analyzes the problems and prospects of advanced industrial economies. Focus is on the role of state government in developing a strategy to promote economic development and create jobs. *M.P.A. elective.*

POL 3618 Problems in Urban Planning

An exploration of the resources available to the urban planner for policy implementation, including zoning, subdivision regular action, and capita improvement programs. Special emphasis is given to the planning of individual sites. *M.P.A. elective.*

POL 3619 Techniques of Urban Planning

A study of the history and techniques of city planning, stressing the elements of planning. *M.P.A. elective.*

POL 3620 Politics of State and Urban Planning

An investigation of the relationships of planning to other governmental functions with stress on practical processes, particularly at the municipal government level. *M.P.A. elective.*

POL 3621 Problems of Urban Development

An examination of the role of government and politics in the planning, programming, and administration of

regional and urban development in the United States. Consideration is given to urban renewal; interurban and interregional competition; interstate compacts; public authorities; T.V.A., Appalachia, and New England regional development; antipoverty programs; and conflict between public and private interests. Individual research is stressed. *M.P.A. elective.*

POL 3622 Urban Government

The contemporary crisis in urban government—problems of political independence, government finance and administration, rapid growth of suburban and metropolitan areas, and decline and decay of the core city are stressed. Particular emphasis is given to the Boston metropolitan area. Individual research is stressed. *M.P.A. elective.*

POL 3623 Transportation Policy

Examination of the role of politics, governmental mechanisms, and public policy in the transportation planning process. Particular attention is given to political interest groups and the manner in which they affect transportation policy on the federal, state, and local levels. *M.P.A. elective.*

POL 3624 Problems of Community Development

Examination of the role of government, politics, and public policy in the urban process and related problems in the United States. *M.P.A. elective.*

POL 3625 Collective Bargaining in the Public Sector.

Study of the mechanism for labor relations in federal, state, and local government with its impact on the public manager. Emphasis is placed upon collective bargaining processes, tactics, and techniques. *M.P.A. elective*

POL 3626 Grantsmanship

This course provides students the opportunity to increase their knowledge of the federal grant system. Emphasis is placed on developing the ability to write effective grant proposals and on improving management skills.

POL 3627 Management Information Systems

The course studies the life cycle of a management system through its three phases: (1) study and design; (2) implementation; and (3) operation within the target organization. Focus is on exploring the impact which management information systems have and may have in the future on governmental managers, on their professional environment, and on the society which they serve. Various government MIS will be studied. The course requires no mathematical or data-processing background. *M.P.A. elective.*

POL 3629 Computers and Public Administration

A general orientation to the computer, its uses and operation, with particular attention to programming analysis, preparation and coding, and use of computer programs specifically written for governmental applications. *M.P.A. elective.*

POL 3630 Health-Care Administration

An examination of the politics and administration of health-services delivery systems, including a dis-

cussion of current topics in health-care administration and politics (e.g. national health insurance, health-maintenance organizations, physician assistants, citizen participation, administration decentralization) and an introduction to current developments in policy evaluation methodology and health-services research. *M.P.A. elective.*

POL 3631 Urban Development

This course is designed to help students analyze urban development issues and to learn how to be effective in creating and implementing public development policy and programs. We will explore subsidies and taxes, housing, commercial and industrial development, and job creation and training projects in terms of their historical, political, economic, and social dimensions. The emphasis is to learn to develop a development program through the role-playing method. *M.P.A. elective.*

POL 3632 Public Fiscal Management

A study of the interrelationships in public administration between systems of finance and the achievement of program objectives. Emphasis is placed upon those aspects of the budgetary process that bear on fiscal policy and appropriations. *M.P.A. core course.*

POL 3634 Functions and Techniques of Public Management

An introduction to problems in public management and techniques for dealing with them including functions of middle management, supervision, administration of staff activities (e.g. planning, personnel, budget), organization and methods, public relations, managerial use of computer-based techniques, and tactics and strategies of management. *M.P.A. elective.*

POL 3635 Environment and Energy Policy

Consideration of the legal, political, administrative, and intergovernmental factors involved in the formulation of public policy and the exercise of public power in regulating the use of the environment. Individual research is stressed. *M.P.A. elective.*

POL 3637 Comparative Public Administration

A comparative study of approaches to public administration in selected democratic governments in the United States and Europe. *M.P.A. elective.*

POL 3639 Federal Administrative Law

Study of rule making, adjudication (formal and informal), administrative finality and judicial review, administrative procedure, scope of administrative powers, and enforcement techniques. *M.P.A. elective.*

POL 3640 Governmental Accounting

Examination of principles and procedures involved in governmental accounting. *M.P.A. elective.*

POL 3641 Techniques of Program Evaluation

A review of the various methods used to assess public policy including identification and categorization of outcome, input and program operation variables; types of research designs; and steps needed to institute program change after completion of an evaluation study. *M.P.A. elective.*

POL 3642 Management Planning and Decision Making

A review of the growth of the planning approach to public management and of its application in specific agencies. Topics include organization of the management planning function, budget planning, and methods of providing planning forecasts. *M.P.A. elective.*

POL 3643 Organizational Psychology and Behavior

Examination of the literature, theories, and concepts of administrative behavior as it has evolved with emphasis on the development of self-awareness and the building of interpersonal skills. *M.P.A. elective.*

POL 3644 Public Policy Issues in Human Services

Discussion of the origins and development of the Social Security Public Assistance Income Maintenance and various health-care programs. The course content focuses on controversial public policy issues of retirement, survivors, disability insurance, Aid to Families with Dependent Children, Medicare, and Medicaid, with the objective of helping students to develop understanding of the push and pull of many different viewpoints involved in public policy development. *M.P.A. elective.*

POL 3645 Program Implementation

This course examines the implementation stage of the policy process, specifically the implementation of federally funded social programs by local governments. Topics include: intergovernmental fiscal configuration; the capacity to implement; the politics of implementation; implementation feasibility.

POL 3646 Position Management

An examination of the bases of position classification at the state, federal, and local levels. After reviewing the process of job analysis, the course examines several classification schemes including the new federal factor benchmark system. Final topics include wage and salary administration. *M.P.A. elective.*

POL 3647 Manpower Policy and Administration

Introduces the student to human resource policy and management issues within a broader context of social policy. Includes an investigation of specific manpower programs and current issues of importance to the administrator. *M.P.A. elective.*

POL 3649 Regulatory Administration

This seminar is designed to offer the public manager a conceptual and historical overview of the development of regulatory policy and mechanisms, focusing on issues at the public-private interface as well as evaluating the practical implications of government intervention. Also included is an evaluation of the political, economic, and administrative effects of a nonregulatory vs. regulatory approach to public management. *M.P.A. elective.*

POL 3650 Group Dynamics

Based upon an introductory understanding of organizational psychology and behavior, this seminar focuses on the human problems public managers face in their daily work. Using a group dynamics

format, each participant will have the opportunity to integrate the literature in organizational psychology, work issues, and personal growth concerns. *M.P.A. elective.*

POL 3652 Civil Liberties in Public Administration

Discussion of First Amendment rights as they impact upon the public sector. Referring to appropriate court cases, topics include employee rights and obligations with respect to freedom of speech, freedom of association, loyalty oaths, and professional certification, as well as legislative powers. *M.P.A. elective.*

POL 3653 Survey Research for Public Administration

Focuses on the entire survey research process from ample selection to data analysis. Regression for time series analysis and some computer applications are discussed. *Prereq. POL 3605*

POL 3654 Computer Software for Public Administrators

This course will be offered as an elective at least once per year. The course will provide an introduction to several software packages for: statistics; management file construction and use, word processing, and graphics. *Prereq. POL 3605.*

POL 3655 Politics and Administration in Cities and Towns

An examination of the political and administrative structures which influence the conduct of city and town governments. Particular attention is given to the dynamic relationships between these structures and the implications for public policy-making. *M.P.A. elective.*

POL 3656 Business-Government Relations

This course extensively examines the relationship between the United States government and the private economy from a historical and a contemporary perspective. A number of public policy areas in which public and private actors interact will be analyzed. Stabilization policy, regulation, antitrust, and social welfare policy will be examined in the context of alternative interpretations of the U.S. political economy. *M.P.A. elective.*

POL 3657 Organizational Analysis

A study of the structure and processes of organization essential for problem solving and for effecting organizational change. Emphasis is placed upon the application of social science theory and administrative principles in administrative problem identification and problem resolution. *M.P.A. elective.*

POL 3658 State and Local Finance and Budgeting

This course explores the many channels that the state budget must travel before it becomes a viable document. The several ways by which the budget can be affected before and after it is signed into law are explored in depth. *M.P.A. elective.*

POL 3659 Municipal Finance

A discussion of the special problems of budgeting and finance in local governments, including budget

preparation and presentation, debt management, capital financing, and local taxation policy. *M.P.A. elective.*

POL 3660 Development Planning

Development Planning focuses on the dynamics and activities of host-government, bilateral, and multilateral organizations as they analyze and tackle such problem areas as agriculture, education, health, population, and land reform in developing countries. Specific attention is paid to the special role of public administration in less developed countries. *M.P.A. elective.*

POL 3661 Municipal Law

Designed for the nonlawyer, this course reviews the law of municipal corporations. Topics include general powers and duties, charters, ordinances, administrative rules and regulations, officers and employees, tort liability, policy powers, planning and zoning, taxation and borrowing, elections, and licenses and permits. *M.P.A. elective.*

POL 3662 Comparative Urban Government and Administration

This course analyzes decision-making structures and processes in selected urban areas, including an examination of world organization trends and implications for administration and politics of cities; changing scopes, scale, participants, and organization of urban politics; and selected issues such as urban housing, finance, leadership, planning and goals. *M.P.A. elective.*

POL 3663 Techniques of Public Budgeting

Introduction to the practical skills necessary for the formulation, evaluation, and presentation of budget data. Budgetary information (raw data) provided from computer simulations and from state and local governments is analyzed and adapted to various types of budget formats. *M.P.A. elective.*

POL 3664 Contemporary Issues in Public Finance and Budgeting

The study of public budgeting in the context of the political, financial, and economic environment of present-day government. A heavy focus on contemporary issues and events which affect budgetary processes in the public sector is included. *M.P.A. elective.*

POL 3665 Women in Public Management

Analysis of the multiple roots of problems experienced by women in public management positions and solutions for alleviating such problems. Student are expected to engage in experiential learning exercises in addition to academic work. *M.P.A. elective.*

POL 3666 Housing Crisis

This course surveys the housing problems associated with the poor, the elderly, and middle-class citizens. It studies housing policies which have been enacted on the national and local levels and assesses the impact of these policies.

POL 3667 Equal Opportunity in Public Administration

This course is designed to (1) examine barriers to EEO, (2) help students develop an awareness of issues surrounding the Affirmative Action Program and particularly some of the historical perspectives of discrimination against minorities and women; and (3) offer instruction in techniques for developing a meaningful equal opportunity program for public organizations. *M.P.A. elective.*

POL 3668 Legal Issues in Public Personnel Administration

A review and discussion of fact situations and evidence which give rise to public employment litigation with emphasis on civil rights and Equal Employment Opportunities court actions. Class discussion includes the type of evidence used in litigation and the types of defenses available to public employers. *M.P.A. elective.*

POL 3669 Labor Relations in Public Administration

Examination of various theoretical models for analyzing labor-relations structures and dynamics as well as their historical development in the United States. Where appropriate, attention is given to private sector patterns for comparative analysis. Among the topics treated are bargaining unit determinations, management rights and the scope of bargaining, coalition bargaining, impasse-procedure options, contract administration, affirmative action, civil-service traditions, and public sector unions. *M.P.A. elective.*

POL 3670 Public Relations in Public Administration
Focuses on evaluating the public manager's role in the process of communication with the public. Issues of imagery and accountability as well as current topics are evaluated. *M.P.A. elective.*

POL 3671 Social Welfare Policy and Administration

The historical, political, social, and economic determinants of the U.S. social welfare system are examined. Present policies and programs are analyzed using a dynamic systems model. Practical experience from all levels of government is included. *M.P.A. elective.*

POL 3673 Career Development

Designed to help students make career choices, identify their own career stages, and better understand their role as part of a work organization, with the purpose of assisting students in career planning. *M.P.A. elective.*

POL 3674 Federal, State and Local Financial Relations

As state supervision of and assistance to local governments in the area of financial administration is becoming increasingly important, this course explores the relationships between the two levels of government in the assessment and collection of taxes, budgeting, debt management, and state aid. In addition, the federal role and fiscal intergovernmental relations are evaluated. *M.P.A. elective.*

POL 3675 Health Policy and Politics

An analysis of health care policies, procedures, and alternatives.

POL 3676 Practices in Self-Development in Public Management

This course focuses upon practical aspects of public management. Topics include time management, communication (e.g., memorandum and report writing), control processes, and conflict management.

POL 3677 Elder Services Policy and Administration

This course investigates the historical, socio-economic and philosophical determinants of the emerging elder services system. Present policies and programs are studied using various comparisons, case studies, and dynamic models. Focus on contemporary problems in the administration of elder care delivery systems, funding sources, and future trends.

POL 3678 Federal Bureaucracy

Examination of dynamic and structural aspects of the national government, with attention to the place of the national administration in the federal system. *M.P.A. elective.*

POL 3679 Case Studies in Developmental Administration

Using the case-study method, students will simulate actual management situations on the project level. Open to those students who have completed Development Administration (POL 3615), or by permission of the instructor. *M.P.A. elective.*

POL 3690 Topical Seminar

The program occasionally offers a special seminar dealing with current important issues relevant to public administration.

POL 3696 Politics of Finance and Budgeting

This course examines the political environment of public budgeting from both historical and contemporary perspectives. Special attention will be given to the relationship between executive and legislative institutions at the federal, state and local levels. *M.P.A. elective.*

POL 3697 Seminar in Public Personnel Administration

Analysis of specified topics and issues in public personnel administration with the purpose of presenting material of current interest and allowing in-depth research into specified areas where appropriate. Subject matter to be covered is described in registration materials. *M.P.A. elective.*

POL 3698 Case Studies in Policy Analysis

This course provides the opportunity for detailed analysis of key issues in public policy. Students will complete oral and written analyses of case studies that reflect these issues. Emphasis is placed on developing the ability to utilize the relevant analytic techniques in resolving the problems confronting government. *M.P.A. elective.*

POL 3699 Seminar in State and Urban Administration

Analysis of specified topics and issues in state and urban administration with the purpose of presenting material of current interest and allowing in-depth research into specified areas where appropriate. Subject matter to be covered is described in registration materials. *M.P.A. elective.*

POL 3798 Master's Thesis Continuation

POL 3884 Assigned Reading 1 Q.H.
Assigned reading under supervision of a faculty member.

POL 3886 Assigned Reading 3 Q.H.
Assigned reading under the direction of a faculty member.

POL 3890 Assigned Reading 6 Q.H.
Assigned reading under supervision of a faculty member.

POL 3892 Internship Readings and Analysis
Academic credit directly related to an internship assignment.

POL 3895 Thesis 6 Q.H.
Thesis supervision by individual members of the department.

Psychology

All courses carry three quarter-hours of credit unless otherwise specified.

PSY 3111, PSY 3211, PSY 3311 Quantitative Methods I, II, III

A survey of the quantitative methods used in experimental psychology, emphasizing applications of computer programming, theory of functions and relations, curve fitting, probability functions, set theory, and analysis of variance.

PSY 3113, PSY 3116, PSY 3118, PSY 3115**Proseminar I, II, III, IV** 4 Q.H.

The departmental proseminar faculty lectures, student presentations, and discussions of the experimental literature in the following areas: learning, motivation, and behavioral analysis; sensation and perception; neuropsychology, language and cognition.

PSY 3119, 3219, 3319 Attention I, II, III

Seminars dealing with the topic of attention (selective and general, e.g., arousal, attentiveness, etc.). Behavioral, cognitive and physiological aspects will be discussed.

Learning and Behavioral Analysis

PSY 3121 Experimental Design in Applied Research

Detailed study of experimental methods, emphasizing critical analysis of published research reports and the implementation of the methods in service settings. Students have the opportunity to learn and evaluate observational measurement and data-collection techniques. A feasible experimental design, with graphed actual or hypothetical data, must be written in the form of a scientific report.

PSY 3122, PSY 3222, PSY 3322, PSY 3422, PSY 3522 Applied Programming Seminar I, II, III, IV, V

Students are expected to design, test, and evaluate instructional programs for teaching specific subject matter for remedial application to behavior problems and to test instructional theory. Supervision is provided by a weekly programming research and data seminar in collaboration with the student's adviser.

PSY 3123 Programmed Learning

A review of the history and theoretical and experimental bases of programmed instruction and errorless learning. Emphasis is placed on the detailed analysis of stimulus control—its measurement, and ways to produce it.

PSY 3129 Mental Retardation Seminar

Interdisciplinary seminar taught by faculty from the several Boston-area universities associated with the University-affiliated facility. The role of each discipline in the care and treatment of retarded people is defined and coordinated with the functions of other relevant disciplines. Specialties include communication disorders (Emerson College), dentistry (Tufts University), medical disciplines (e.g., pediatrics, neurology, orthopedics, genetics—Massachusetts General Hospital, Harvard Medical School), nursing (Boston University), nutrition (Framingham Teacher's College), occupational therapy and physical therapy (Sargent College of Boston University), social work (Boston University and Simmons College), sociology (Brandeis University), special education (Boston University), and psychology (Northeastern University).

PSY 3132, PSY 3232 Behavior Intervention I, II

Students are given instruction in behavioral intervention techniques. Emphasis is placed on the functional analysis of behavior.

PSY 3133, PSY 3233, PSY 3333 Advanced Learning Seminars I, II, III

These seminars cover contemporary research in operant conditioning, with emphasis on relating the techniques of behavioral analysis to problems of reinforcement, motivation, comparative psychophysics, and physiological psychology.

PSY 3143, PSY 3243 Learning Principles and Applications I and II 4 Q.H.

An analysis of principles from behavioral learning research and their application to the process of behavior change for learning, remediation, and treatment. Particular emphasis is on educational settings.

PSY 3229 Administration of Mental Retardation Services

Presents comprehensive overview of general and specialized services for retarded individuals from organizational and administrative points of view. Issues in planning and initiating new programs, service delivery, staffing, and economics are covered. Visits to varied types of facilities focus on administrative concerns.

PSY 3321, PSY 3421, Systematic Inquiry in Applied Research I, II

Each student is expected to collect a comprehensive bibliography on a significant topic in applied behavior research and complete a thorough review via written and oral presentations. Emphasis is placed on the integration and analysis of experimental findings and theoretical foundations of the research area, the critical evaluation of current research, and the definition of potentially fruitful future work.

PSY 3649 Community Based Treatment 3 Q.H. (Prereq. Permission)

The treatment of mentally retarded individuals in a community setting.

PSY 3324 Behavior Change in Institutions

A review of successful projects which have been carried out to provide effective remediation and rehabilitation in institutions for the mentally retarded, the juvenile delinquent, and the developing individual (schools).

Sensation and Perception

PSY 3185 Electrophysiological Recording

Methods for recording electrophysiological activity from the human subject including electroencephalography, auditory and visual-evoked potential recording, electroretinography. Consideration of some of the principal findings that have been obtained with these methods and their importance for the interpretation of a variety of psychological phenomena.

PSY 3188, PSY 3288, PSY 3388 Vision I, II, III

Seminars: classical and modern problems in vision. Recent journal articles provide primary source materials for discussion. Consideration is given to problems of stimulus specification, retinal structure, photochemistry, and psychophysical measures of sensitivity, color vision, and electrophysiology.

PSY 3189 Psychoacoustics

This seminar deals with the relationship between sound and auditory perception. After five tutorial sessions on the physics and laboratory generation of sound, thresholds, masking, loudness, pitch, and sound localization, students are expected to lead discussions based on research papers in the psychoacoustic literature.

PSY 3289 Perception

A detailed consideration of research in such areas as form, space, and pattern perception, recognition, and the effects of set and motivation on perception. Physiological concomitants of perceptual phenomena are considered.

PSY 3418 Modern Psychophysics

A mathematical study of signal-detection theory; human and animal psychophysical methods; theory of the ideal observer.

Neuropsychology

PSY 3127, PSY 3128 Neurological and Sensory Impairments Seminars I, II

Etiology, assessment, and diagnosis, clinical characteristics, and education of the mentally retarded with visual, hearing, and motor deficits are studied. In addition to discussion, experiences are provided in evaluation and remedial programming, via the application of operant techniques.

PSY 3145 Human Neuropsychology 1 3 Q.H.

This course in neuroscience addresses brain function and structure. Specific disorders seen in the clinical population are related to disfunction of the nervous system.

PSY 3151 Brain and Behavior I

An introduction to basic methods of physiological psychology, including animal surgery, electrical stimulation of the brain, electrophysiological recording, and histological techniques. Students have the opportunity to gain experience in these methods by carrying out a limited research project during the semester. Enrollment limited to ten. *Prereq.: Admission to doctoral candidacy or permission of instructor.*

PSY 3155, PSY 3255 Sensory Psychophysiology I, II

Concentration on the anatomy and physiology of the various sensory systems and correlation of these data with psychophysical and perceptual concepts. Laboratory work is included.

PSY 3159 Neurochemistry and Behavior

This seminar examines different experimental approaches to the problems involved in uncovering the relationships between changes in brain activity and changes in behavior produced by drugs. Discussions center on current theorizing on the role of early experience, environmental factors, biological rhythms, and other facets in the determination of drug-induced behavioral changes.

PSY 3225 Biological Bases of Mental Retardation

The course considers the relationship between biological malfunction, of the brain in particular, and the defective learning ability and other behavioral abnormalities which constitute mental retardation. The aim is toward a comprehensive a survey as time permits. Exercises include actual case presentations as illustrative examples.

PSY 3251 Brain and Behavior II

Selected topics in the neurophysiology of perception, emotion, motivation, learning, and memory will be pursued in depth, with emphasis upon a critical evaluation of recent literature. Enrollment limited to fifteen. *Prereq.: Admission to doctoral candidacy or permission of instructor.*

PSY 3355, PSY 3455, PSY 3555 Physiological and Comparative Psychology I, II, III

Seminars: a shared background, key concepts, and central issues in the field of physiological and comparative psychology.

Language and Cognition**PSY 3126 Child Language Development**

Learning theory approaches to language acquisition are contrasted with psycholinguistic and neurogenic theories. Works of Skinner and Chomsky are analyzed, and implications for both normal and abnormal language development are discussed.

PSY 3161, PSY 3261 Cognition and Psycholinguistics I, II

Research in cognition and psycholinguistics.

PSY 3166 Psycholinguistics

Seminar. In-depth analysis of research methods and findings in selected problems in the psychology of language, including developmental, anthropological, and experimental psycholinguistics.

PSY 3169 Seminar in the Structure of American Sign Language

This seminar is designed to introduce students to current issues in linguistic theory as well as to update them on the specific literature on ASL research. Focus is upon one particular area of linguistic theory as it relates to current ASL research, e.g., phonology, morphology, syntax, semantics, or discourse (varies from year to year).

PSY 3264 Language Acquisition 3 Q.H.

An overview of issues in language acquisition will be integrated with in-depth discussions of selected topics.

PSY 3269 Linguistic Theory and ASL: Special Topics 3 Q.H.

(Prereq.: Introduction to ASL Linguistics or Introduction to Linguistics)

This seminar will vary year to year. Each year we will focus upon a particular body of literature related to current linguistic theory and its relevance to ASL. The course will involve extensive reading of current articles and dissertations in linguistics in general and in ASL Linguistics. Students will be expected to do presentations during the course of the seminar.

Experimental Personality and Social Psychology**PSY 3171, PSY 3271 Psychopathology I, II 4 Q.H.**

A detailed consideration of the major forms of psychopathology, including the neuroses (obsessional

states, hysteria, anxiety states, phobias), the psychoses (schizophrenia, mania, depression, paranoia), psychosomatics, sociopathy, conduct disorders, organic disorders, and mental retardation.

PSY 3371 Social Psychology

Survey of theory and research in social psychology. Topics covered include attitude and attitude change, aggression, altruism, group processes, person perception, and social cognition.

PSY 3477, PSY 3577, Personality Theory and Research I, II

A survey of representative theoretical formulations of the normal personality and its development, and an examination of experimental evidence bearing upon relevant concepts and assumptions (anxiety, repression, aggression, cognitive styles).

Special Topics**PSY 3291 Research Laboratory 1 Q.H.**

Students and their faculty advisers discuss laboratory projects, current literature, theory, and applications.

PSY 3419 Special Topics in Psychology max. 9 Q.H.**PSY 3521 MABA Research 0 Q.H.**

Students enrolled in the M.A.B.A. program may sign up for this course beginning in their *third* year to indicate that they are continuing their research.

PSY 3549 Practicum 3 Q.H.

Supervised practicum experience emphasizing the application of principles of psychology to human behavior.

PSY 3798 Master's Thesis Continuation 0 Q.H.

Continuation of experimental work for the master's degree requirement.

PSY 3799 Doctoral Dissertation Continuation 0 Q.H.

Continuation of experimental and theoretical work for Ph.D. candidates.

PSY 3891 Thesis 6 Q.H.

Experimental work for the master's degree requirement.

PSY 3894 Dissertation 0 Q.H.

Experimental and theoretical work for Ph.D. candidates.

Business Administration

Graduate School of Business Administration

All courses carry four quarter-hours of credit unless otherwise indicated. Please see the current schedule for summer, fall, winter, and spring quarter listings.

ACC 3781 Health Care Accounting and Control

This course examines hospital and other health organizations' managerial accounting requirements and practices. Rate setting and reimbursement policies and their effect on cash flow and the financial position of health institutions are also examined.

Prereq.: ACC 3813.

ACC 3811 Financial Accounting

An introduction to the accounting system and the techniques of recording, summarizing, and reporting the flow of financial information through the entity concerned. The course presents an examination of the information flow process plus the necessary techniques for analysis and evaluation of the firm's potential in the light of historical data. *Prereq.: none.*

ACC 3812 Management Accounting

An examination of the role of accounting in controlling the operation of the business entity and the relation of cost and volume to profits. Decision-making techniques using accounting information are stressed. The use of programmed budgets as a planning, motivating, coordinating, and control device is emphasized. *Prereq.: ACC 3811.*

ACC 3813 Management Control Systems

The study of short and long-range programs and their integration within the control mechanism; the enhancement of goal setting, achievement, motivation, and evaluation. Primary emphasis is on the decentralized organization with multiple operation divisions. *Prereq.: ACC 3812.*

ACC 3903 Management Control in Nonprofit Organizations

This course will utilize lectures, class discussions, and case discussions to help students develop an understanding and working knowledge of: the role of the manager in the nonprofit control process; the design and implementation of a new control system; the management of a system which will adapt to changing environments and organizational needs; the characteristics of bureaucratic behavior and problems associated with implementing a control system where it may not be desired or understood; and methods of defining and relating the inputs and outputs of nonprofit organizations, including the use of cost accounting, capital and program budgeting, personnel systems, and benefit/cost analysis. *Prereq.: ACC 3813.*

ACC 3918 Corporate Financial Reporting and Analysis I

An intensive investigation of contemporary financial reporting problems. Conceptual and pragmatic issues of income determination and financial disclosure are discussed. Primary emphasis is placed on interpretation and analysis of alternative accounting

treatments. The perspectives of various financial statement user groups are explored. *Prereq.: ACC 3812.*

ACC 3919 Corporate Financial Reporting and Analysis II

Continued examination of the financial reporting environment. Analysis of the economic consequences of complex transactions and related disclosures. Survey of current reporting requirements and analysis of recent developments in financial reporting. *Prereq.: ACC 3918.*

ACC 3922 Auditing

An introduction to the function of the public accountant. Matters of professional conduct and ethics, legal liability, generally accepted auditing standards, internal control, statistical sampling, audit reports, and the impact of electronic data processing on auditing are covered. Although a conceptual approach is employed, auditing procedures as they relate to specific areas are covered. *Prereq.: ACC 1112.*

ACC 3962 Tax Factors in Business Decisions I

A survey of the Internal Revenue Code and its implications for choice of organizational form, corporate reorganizations and compensation policies. Mergers and acquisitions and the management of depreciable property are examined in the light of decisions made by the Internal Revenue Service and the tax courts. Emphasis is on tax planning and research into corporate income tax problems that affect business decisions. *Prereq.: 15 q.h. of grad. credit.*

ACC 3963 Tax Factors in Business Decisions II

This course is designed to establish an in-depth understanding of selected tax planning topics: deferred compensation plans, mergers and acquisitions, small business organization, and business planning interaction with estate planning. *Prereq.: ACC 3962 or permission of instructor.*

ENT 3922 Small Business Consulting

This course is designed to help students who have completed courses in the major functional areas achieve insights into the consulting sector of our business society. Special emphasis is placed upon tools used in problem identification and in seeking realistic solutions for the small business community. Each student will be assigned to a team that will be applying these skills with a small business in an attempt to find solutions to a real, current problem. A final written report and oral presentation is required for this consulting assignment. *Prereq.: 15 q.h. of grad. credit.*

ENT 3929 New Ventures: A Career Choice

Enables students to examine the nature of entrepreneurship and the appropriateness of self employment for an individual. Focus is on the decision to own and operate one's own business. Students have the opportunity to examine the values, motivations, goals, and life style required by the entrepreneurial role. Guest speakers, cases, selected readings, and self-assessment exercises help students identify the congruency between their own interests and goals and an entrepreneurial career. Also recommended for prospective loan officers, investment bankers and venture capitalists, CPA's, management consultants, and others whose career activities may involve them with entrepreneurs and managers of new ventures or smaller companies. *Prereq.: 15 q.h. of grad. credit.*

ENT 3965 Management of Small Business Enterprises

Explores the operating problems of managing small enterprises. Case studies develop analytical approaches for appraising the risks and rewards of potential growth opportunities, as well as operating problems. Problems range from locating, evaluating, and financing a small company to the survival and growth of an established business. Guest speakers relate pertinent business experiences to in-class activities. *Prereq.: 15 q.h. of grad. credit.*

ENT 3968 Management of New Enterprises

This course discusses the basic ingredients of small business, including problems and pitfalls. There is an orientation toward entrepreneurs including start-ups and buy-outs. Topics include 1) business opportunities introduced through new ideas, product development, licensing, inventions, patents, etc., and 2) organization, start and growth of a new business on the acquisition of a going concern, including fund raising and related regulations. *Prereq.: 15 q.h. of grad. credit.*

FIN 3760 International Financial Management

Deals with the specific concepts, policies and techniques for the financial management of the multinational firm are discussed in this course. Specific topics include operations of the foreign exchange markets, managing foreign exchange risk, sources and instruments of international financing, foreign direct investment and the management of political risk, multinational capital budgeting, and financing control systems for the multinational firm. *Prereq.: FIN 3812.*

FIN 3770 Small Business Finance

This course utilizes the basic processes, principles, tools, and concepts of finances within the parameters of a small business to develop a complete financial plan. The main objective is to construct a comprehensive plan that projects the future circular flow of funds by analyzing and then integrating the impact of both investment decisions (use of funds) and financial decisions (source of funds). *Prereq.: FIN 3812.*

FIN 3811 Financial Management I

This course and its required sequel, FIN 3812, present concepts, practices, and procedures of financial management, and offer training in analytical approaches helpful in making wise decisions affecting the flow of funds available to an organization. Topics include financial analysis and forecasting, domestic and international working capital management, and an introduction to security types and markets. Instruction is primarily through readings and cases. *Prereq.: ACC 3812.*

FIN 3812 Financial Management II

Through readings and cases, this course concentrates on long-term sources and uses of funds, including capital budgeting techniques, dividend policies, and the concept of cost of capital. Risk and return trade-offs are also studied. Broad topics of overall financial strategy and timing are examined in both a domestic and an international setting. *Prereq.: FIN 3811.*

FIN 3901 Financial Strategy

This course offers the opportunity to study several important areas of financial management in greater depth than is possible in the basic finance courses. Emphasis is on strategies that financial managers can pursue to maximize the value of their firms. Instruction is primarily through reading and classroom case discussions. *Prereq.: FIN 3812.*

FIN 3916 The Management of Financial Resources

A thorough analysis of capital budgeting techniques and portfolio considerations is combined with an assessment of factors affecting a firm's capital structure. Company assets and how they should be financed are the central questions. The most recent developments in financial management are explored. *Prereq.: FIN 3812.*

FIN 3918 Working Capital Management

This course examines strategies of and analytical approaches to managing current assets and current liabilities. It explores corporate cash management under changing money market conditions and discusses the use of interest rate futures and working capital management in a multinational context. *Prereq.: FIN 3812.*

FIN 3920 Real Estate Investment and Analysis

This course helps provide students with a comprehensive understanding of real estate finance. Factors affecting real estate investment are emphasized. Specific topics covered include: valuation (appraisal), market analysis, development, taxation, ownership types, short-term financing, mortgage markets, and investment strategies. The course is designed for students interested in a general overview of real estate finance, as well as those intending to pursue a career in the real estate field. *Prereq.: FIN 3812 and MSC 3803.*

FIN 3921 Investment Analysis

Focuses on the development of a sound investment program, with attention to identification of investment

principles, objectives, and risks. Emphasis is placed on the techniques of analysis, evaluation of various types of securities and the associated risks, the operation of the securities markets, and the various methods of portfolio management. *Prereq.: FIN 3812.*

FIN 3924 Mergers and Acquisitions

The environments that have recently given rise to a large number of corporate mergers and the business factors underlying these corporate combinations are the focus of this course. The financial, managerial, accounting, and legal factors affecting mergers are examined. Students have an opportunity to learn how to appraise a potential merger and structure a merger on advantageous terms. *Prereq.: FIN 3812.*

FIN 3925 Investment Banking

Issues presented are associated with policy, strategy, and administration of investment banking firms. Topics include issuance of securities, the service function of investment bankers, pricing a negotiated issue of common stock or competitive bid issue, and meeting the capital requirements of a securities firm. *Prereq.: FIN 3812.*

FIN 3926 Bank Management

Case studies and analyses are used to examine the management policies of commercial banks. The focus is on the lending, investment, and liquidity management policies of these financial institutions and on the current issues and problems they face. *Prereq.: FIN 3812.*

FIN 3927 Portfolio Management

This course deals with portfolio construction, revision, and performance measurement. Portfolio construction in an efficient capital market is highlighted. Critical subjects to be explored are risk-return analysis, the effects of diversification on risk reduction, and the costs of inflation, taxes, and transaction costs on fixed income and equity security portfolios. Financial models of capital asset pricing are examined as the basis for the analysis of portfolios from the institutional investor's viewpoint. *Prereq.: FIN 3921.*

FIN 3928 Risk Management and Insurance

This course introduces the student to the concepts of risk and risk bearing in the business firm. It examines risk identification and analysis, measurement of loss possibilities, and the principal methods of managing such contingencies. The focus of the course is broad enough to include some nontraditional areas, such as speculative risk and foreign operations. Insurance is discussed in detail as a major method of managing certain types of risks. Particular emphasis is placed on aspects that directly relate to the financial management function, such as insurance markets and products, selecting insurers and insurer intermediaries, legal frameworks involved in the transfer of risk to insurers, pricing of insurance contracts, and principles followed by insurers in selecting risks. *Prereq.: FIN 3812.*

FIN 3932 Options Markets

This course provides students with a comprehensive understanding of the options markets. Topics include the structure of options markets and options contracts, option pricing models, option trading strategies, and the risks and opportunities of investment in options. *Prereq.: FIN 3812.*

FIN 3935 Management of Financial Institutions

This course offers a broad study of the decision-making problems faced by financial institutions such as commercial banks, thrift institutions, pension funds, insurance companies, and finance companies. Topics include the nature and scope of the capital markets confronting these institutions, specialized problems regarding their sources and uses of funds, the nature of the competition, regulatory constraints, and strategic policy planning of the financial institutions. *Prereq.: FIN 3812.*

FIN 3936 Seminar in Finance Theory

This seminar provides an intensive coverage of issues in the theory of finance. A framework of conceptual knowledge is built and the evidence to support the theory is examined. A survey of the current literature, student research, and the presentation of papers form important components of the seminar. *Prereq.: FIN 3812.*

HRM 3760 International Human Resource Management

This course covers basic issues in human resources management relevant to managing in international and cross-cultural environments. Topics include selection and training of personnel for work in multicultural environments, managing the international employee in the United States and abroad, cross-cultural communication, international environments, special issues of concern to small business, and change in multinational companies. *Prereq.: 15 q.h. of grad. credit.*

HRM 3784 Human Resource Management in Health Organizations

Relates the traditional personnel (human resource management) functions: service, audit and control; the new functions: corporate policy formulation planning, advice and counsel, and innovation to the unique problems of Health Care Organizations. To a large extent union organization and negotiation efforts, depicted in cases and mock negotiation exercises, focus on the conflicting issues between traditional personnel approaches, and the questioning of management authority and rights by unions and other regulatory policies and agencies. *Prereq.: HRM 3815, HRM 3816.*

HRM 3815, Behavioral Concepts and HRM 3816 Organizational Behavior I

The first half of this two-course sequence examines major concepts and findings of the behavioral sciences which have particular pertinence to business and administration. Systematic ways of understand-

ing behavior, are developed. Specific topics include human development and motivation, interpersonal perception and communication, and small groups processes. The second half of the course sequence relates these basic concepts to specific aspects of behavior in formally constituted organizations. Supervisory behavior is examined in the behavioral context, as well as in relations between groups, in efforts to develop ways of achieving collaboration. *Prereq.: none.*

HRM 3817 Organizational Behavior II

The study of behavior in organizations is expanded in order to understand and deal systematically with the complex relationships found in larger organizations. An opportunity is provided to apply knowledge about people in organizations to the improvement of organizational systems and to the process of achieving changes in organizations. *Prereq.: HRM 3816.*

HRM 3905 Selection and Assessment

This course focuses on personnel recruitment, selection, and assessment. Basic issues and procedures such as realistic recruitment, the impact of the EEOC, decision strategies, and utility will be covered in detail. The basic tools examined will be testing, interviewing, and application blanks. Readings and outside projects will be used in a class discussion/lecture format. *Prereq.: none.*

HRM 3913 Managing Power and Influence

Explores through cases, readings, and videotape the complex issues involved in the use of power and influence in organizations and how to manage these issues in ways that are organizationally effective and socially responsible. Topics include: a) the dynamics of power within organizations; b) the methods by which effective managers acquire and maintain power to manage critical dependencies and uncertainties; c) the important interdependency between power, influence and trust in organizations; d) analysis and action planning around one's own style of influence and use of power; e) the effects of these issues upon one's own career. *Prereq.: HRM 3815, HRM 3816, and 15 q.h. of grad. credit.*

HRM 3914 Management of Professionals

This course is designed to meet the need for improving the managerial effectiveness of professionals who will have increasing responsibility over the functional activities within their organizations. Course material will cover both micro concerns (i.e., individuals and project groups) and macro issues (i.e., organizational structure, design, and interfunctional relationships) including the following broad areas: supervising and motivating professional employees; dealing with professional obsolescence; career orientations; differences between scientific and engineering fields; effective conflict management; effective leadership in professional settings; technical problem solving and decision making; managing project teams; improving group processes; technical conformity, critical roles in the innovation process; effective technology transfer; the role of interper-

sonal, organizational, and architectural factors in effecting intra- and inter-organizational communication and technical information flows; and organizational diagnosis and change. *Prereq.: HRM 3815, HRM 3816.*

HRM 3923 Managing Careers

This course will explore the dynamics through which the concerns, abilities, and experiences of individual employees are juxtaposed with the demands and requirements of various work environments. Students will address issues of individual differences in career orientation, entry and development problems of new employees, career progression patterns and the organization's role in providing training, career support systems, the management succession guidelines. *Prereq.: HRM 3816.*

HRM 3924 Organizational Behavior in a Nonprofit Environment

Human service organizations involved in health care, welfare, and education are studied in reference to recent behavioral theories and concepts dealing with the internal and external complexities and interrelationships of large-scale organizations. Term projects are designed to conduct and analyze a problem situation and develop plans for implementing change. Readings, cases, and seminars. *Prereq.: HRM 3816.*

HRM 3930 Managing Performance: Evaluating Employees at Work

This course will focus on the critical issues of performance appraisal. Major attention will be given to the process of identifying performance criteria, to measurement techniques, and to the conduct of review sessions for administrative and development purposes. Students will be expected to acquire a thorough working knowledge of state-of-the-art appraisal techniques as well as ability to critically analyze and redesign deficient appraisal review systems. *Prereq.: HRM 3815 and HRM 3816 and 15 q.h. of grad. credit.*

HRM 3945 Training and Developing Human Services

This course is aimed at those management generalists and human resource specialists who are concerned with maintaining organizational effectiveness through upgrading of the basic skills and abilities of a broad range of employees. The emphasis will be on diagnosis of the organization to assess whether training and development is needed, on techniques to decide who needs training; on developing an awareness of the many types of training methods and their relative strengths and weaknesses for various groups of employees, and problem areas; and on the design, implementation, and evaluation of training programs. *Prereq.: HRM 3815 and HRM 3816.*

HRM 3951 Executive Development

An examination of the executive position in an organization and the required personal characteristics and skills. The effects of cultural change and shifting mores on motivation and management control, with

their implications for developing appropriate organizational relationships, are examined. Report writing, oral reports, and leading of group discussions are dominant techniques. Student evaluation is encouraged. *Prereq.: 15 q.h. of grad. credit.*

HRM 3952 Interpersonal Dynamics

This course focuses on the human dilemmas which managers face in a wide variety of interpersonal relationships. The emphasis is upon interactions between individuals. The approach is humanistic and pragmatic; interpersonal communication is the central concept; case analysis and experiential learning (role-play) are the key teaching methods. *Prereq.: 15 q.h. of grad. credit.*

HRM 3955 Compensation Management

Covers policies and techniques of wage and salary administration. The course is practitioner-oriented with students designing and implementing compensation plans using case data. The course covers the technical aspects of developing a successful compensation program such as determining, weighing, and measuring compensable factors; assigning a total value to a job; grade collapsing procedures; reviewing wage and salary surveys; synchronizing internal with external salary structure; setting up "within grade" rate ranges; developing individual and group incentive compensation plans; developing group membership rewards; estimating labor costs; controlling and utilizing the compensation systems and complying with government and union compensation policy. Cases and readings will be used in a lecture/class discussion format. *Prereq.: 15 q.h. of grad. credit.*

HRM 3958 Human Development and the Work Place

This course will explore the implications of recent theories about stages of adult development for managing people, careers, and organizations. Concepts of adult mental health, normalcy, and individual and organizational career planning. Techniques for dealing with human resource problems, such as employee assistance programs, will be discussed. *Prereq.: HRM 3815 and HRM 3816.*

HRM 3962 Human Resources Planning

This course focuses on the formulation and implementation of human resources planning strategies for organizations. It is concerned with such issues as the changing demographics of the labor force, forecasting manpower needs, the development of managerial succession systems, career management, performance appraisal, and compensation. Organizational needs assessment and job analysis will be linked to the changing role of government regulations and the human resource management function in corporations. *Prereq.: HRM 3816 and 12 q.h. of grad. credit.*

HRM 3971 Personnel Management

Covers basic personnel functions: recruitment, selection, placement, rewards, compensation, training, and development of employees. Topics also include

the implications of new government regulatory systems such as equal opportunity, safety, and pensions; the implementation of behavioral theories at the workplace; and the partnership of specialists and generalists in the overall management of an organization's human resources. Cases and readings will be used in a lecture/class discussion format. *Prereq.: 15 q.h. of grad. credit.*

HRM 3972 Labor Relations

Review of U.S. labor history and traditional labor policy, as well as implications of new regulatory systems on labor-management relations such as equal opportunity and safety. Overview of collective bargaining processes applied to emerging sectors of union organization, including health care and education. Lectures, cases, and readings. *Prereq.: 15 q.h. of grad. credit.*

HRM 3987 Leadership

This course studies the processes and responsibilities of leadership in organizations. A contingency approach is used which focuses on identifying different types of leadership behavior and on relating particular leadership styles to situational factors. Text, readings, and cases allow for application of the concepts discussed and self-assessment techniques follow the student to evaluate his or her own leadership qualities. *Prereq.: HRM 3815 and HRM 3816.*

INB 3910 Managing the Multinational Enterprise

Deals with international operations at the multinational enterprise; the interface between the firm and the international business environment; current issues in U.S. public policy affecting international business competition with Japan and with LDCs. *Prereq.: MEC 3809.*

INB 3911 Cultural Aspects of International Business

Using a managerial perspective, this course will cover issues that arise when a firm moves from its home country to a host country that may have a different national culture. Although it will usually take the perspective of the U.S.-based firm that operates abroad, it will spend some time on what happens to other national firms operating in the U.S. and in third country environments. The way in which "corporate culture" evolves in the context of national culture and the impact on managers will be a central issue. *Prereq.: 15 q.h. of grad. credit.*

MEC 3808 Managerial Economics I

Macroeconomics for business managers. Acquaints students with the general economic environment and its impact on the firm. Topics include income and employment theory; classical, Keynesian, and monetarist aggregate demand and supply systems; money and capital markets; fiscal and monetary policy. *Prereq.: none.*

MEC 3809 Managerial Economics II

Entails the application of microeconomic principles to the business firm and its competitive environment. Cases and readings are used to demonstrate the practical application of economic models in the de-

cision-making process. Specifically, the course covers demand analysis, production and cost analysis, market structure, and pricing practices. *Prereq.: MSC 3803.*

MGT 3750 Writing for the Professions

This course examines the various forms of business communications and offers practical experience in writing business letters, memoranda, case studies, proposals, and reports. When possible, speakers from business and industry will be invited to address the class on various problems encountered in management and executive level communications. Several short (500-word) papers as well as one or two longer reports will be required. *Prereq.: none.*

MGT 3751 MBA Writing Workshop

The workshop will focus on advanced, analytical business writing rather than on basic writing skills. It will not contain remedial work on basic English or grammar. This intensive workshop consists of four four-hour sessions and focuses on the writing necessary for the persuasive presentation of business decisions. Discussion of sample cases, lectures, exercises and demonstrations reinforce the elements of writing necessary for effective communication.

MGT 3834 Policy: Environmental Analysis

This first of three policy courses focuses on the environment in which strategy must be formulated in profit and nonprofit organizations. Techniques of environmental analysis are included, with particular emphasis on the political-legal, economic, social, and technological environments as they relate to and influence the formulation of strategy. *Prereq.: all other required courses with the exception of ACC 3813, HRM 3817, HRM 3835 and HRM 3836.*

MGT 3835 Policy: The Formulation of Strategy

Building on the materials presented in MGT 3834, this course examines strategy formulation. Particular emphasis is on the process by which strategy is formulated in actual business settings, including the influence of personal values on strategy formulation, who actually makes strategic decisions, what environmental and internal information is required to make strategic decisions, and what criteria are used to make the decisions. The role of different management levels in the process is considered. *Prereq.: MGT 3834.*

MGT 3836 Policy: The Implementation of Strategy

The third required policy course compares and contrasts the approaches to strategy implementation in profit and nonprofit organizations. Topics include organizational structure and behavior, long-range planning, control and motivation systems, information systems, and leadership. All topics are considered within the systems framework of organizational strategy. *Prereq.: MGT 3835.*

MGT 3915 Business and Professional Speaking

This course is designed to give the students an opportunity to develop and deliver oral presentations as they apply to various business settings — focus

is on formal as well as informal speaking situations. Emphasis is placed on helping the student develop skills in dealing with a variety of communication situations. *Prereq.: 15 q.h. of grad. credit.*

MGT 3940 The Chief Executive Officer

Focuses upon the job perspective of the chief executive officer of business organizations. The central element of the course is presentations by and discussions with chief executives of major companies in the Greater Boston area. Additionally, there will be case studies and other literature addressing the job, problems, and opportunities of top managers. Enrollment will be limited. *Prereq.: 30 q.h. of grad. credit.*

MGT 3942 Management Consulting

This course focuses on the skills, knowledge, and attitudes necessary for competence in the “art of consulting.” The analytical, human, organizational, and administrative elements of consulting are discussed, as are the differences between internal and external consultants. In addition, the course examines management consulting as an industry and as a potential profession. This course is intended both for future consultants and for managers who will be using the services of professional consultants. *Prereq.: 15 q.h. of grad. credit.*

MGT 3956 Strategic Planning

This course covers approaches to strategic planning. Guided by a practitioner orientation, it will focus on the techniques, the process, and the organization of strategic planning. Case analyses of actual experiences will give emphasis to strategic planning as an activity to support mainstream strategic decision making and control, although other purposes of strategic planning also will be considered. The course is designed to be of very real and practical benefit to those wishing to develop skills in designing, implementing, evaluating, improving, and participating in strategic planning activities, as well as to those more generally desiring to develop further their “strategic thinking” capability.

MGT 3969 Government and Business

Analysis of the role of government as a regulating force, as well as the nature and impact of government fiscal, economic, and socioeconomic policies on the conduct of business. The political and economic philosophies behind greater government participation in the economic structure of the nation as indicated by public-utility, antitrust, labor, and socioeconomic legislation. *Prereq.: 15 q.h. of grad. credit.*

MGT 3970 Business and Society: Managing Social Issues

An analysis of environmental influences — economic, legal, technical, social, cultural, and ethical — affecting the corporation. The focus is on reconciling the strains generated by these external factors and their impact on managerial decision making. *Prereq.: HRM 3816 and 12 q.h. of grad. credit.*

MGT 3982 Strategic Planning for Health Organizations

This course examines the process of environmental and institutional analysis for strategic planning decisions in health institutions. The impact of these decisions on organizational design, competitive position, and health organization performance is considered through an examination of recent case studies. *Prereq.: MGT 3836.*

MGT 3983 Decision Making in a Hospital Setting: A Middle-Management Perspective

Operational problem solving with hospital constituencies (physicians, nurses, patients) is a demanding responsibility that encompasses legal, ethical, technological, and behavioral dimensions. The primary aim of the course is to demonstrate how decisions are made in the hospital and how management may effectively participate and shape the structure and outcome of decision-making processes. Case examples will cover such areas as "do not resuscitate orders," clinical decision making, physician and nursing power and authority, consensus development, and the like. The pragmatic practitioner orientation of the course will also incorporate experiential exercises and guest speakers. *Prereq.: 15 q.h. of grad. credit.*

MGT 3990 Business, Law, and Society I

An introduction to the theory and practice of the Anglo-American legal systems, with emphasis on the ways in which law, lawyers, and legal institutions interact with the business environment in order to promote and regulate commercial activities. After exploring some of the major social theories concerning the role of "law" in a market economy, we examine leading judicial decisions involving such key legal doctrines as freedom of contract, scope of property rights, and strict tort liability, with the objective of determining to what extent the Anglo-American legal system can accommodate the needs of a modern commercial society and predicting likely directions of legal regulation of business. *Prereq.: 15 q.h. of grad. credit.*

MGT 3997 Special Studies in Business Administration 1 Q.H.

A special tutorial arrangement between a student and a faculty member for a guided reading, research, laboratory, fieldwork, report, or teaching experience. Recommended for graduate students who desire to do advanced work or carry out special investigation of a problem in business administration not specifically covered in the curriculum. Students must petition the Committee on Graduate Study in Business Administration for permission to register for this course. *Prereq.: 15 q.h. of grad. credit.*

MGT 3998 Special Studies in Business Administration 2 Q.H.

See MGT 3997 for course description.

MGT 3999 Special Studies in Business Administration 3 Q.H.

See MGT 3997 for course description.

MKT 3760 International Marketing

The purpose of this course is to help students develop understanding of: (1) the opportunities and challenges facing the international marketing executive; (2) the decision making process in marketing goods abroad; and (3) the environmental forces — economic, cultural and political — affecting the marketing process in the international marketplace. Lectures, discussions, reports, and cases. *Prereq.: MKT 3812.*

MKT 3811 Marketing Management I

The objectives of Marketing Management I and II are twofold: (1) to present the student with a comprehensive examination of basic marketing functions, institutions, and concepts; and (2) to help develop the student's ability to analyze and make recommendations about business problems that involve the creation, distribution, and sale of goods and services. Marketing Management I emphasizes the definition of marketing problems, demand analysis, consumer analysis, and marketing research. *Prereq.: none.*

MKT 3812 Marketing Management II

A continuation of Marketing Management I, with emphasis on the formulation and implementation of marketing strategy. Emphasis is placed on product policy, channels of distribution, pricing, advertising, personal selling, and the development of integrated marketing programs of action. *Prereq.: MKT 3811.*

MKT 3914 Consumer Behavior

Offers development of an understanding of consumer attitudes and behavior processes. Various economic and behavioral models of consumer behavior are examined and evaluated as bases for the planning and evaluation of marketing strategies. The methods of instruction include text, readings, and project. *Prereq.: MKT 3812.*

MKT 3916 Workshop in Negotiating

Objective is to help improve the students' understanding of the negotiations process and their ability to plan and conduct negotiations effectively. Class activities involve readings, lectures, and discussions as well as numerous case discussions and live and videotaped role-play negotiation exercises. *Prereq.: MKT 3812 and HRM 3816.*

MKT 3920 Public Policy and Marketing

The purpose of this course is to acquaint students with the public policy environment in which marketing managers operate and to develop the skills necessary to function in that environment. More specifically, the course will address some of the regulatory and policy-making issues that confront managers in marketing. To that end, students will analyze current issues facing policy makers using the same materials the policy makers rely upon. Students will advocate various positions on these issues, both in

class discussions and written assignments. *Prereq.: MKT 3811.*

MKT 3922 Brand Management

Emphasizes the process of new consumer product development, the management and development of product strategies, and management of the product mix in the multiproduct firm. Topics include identification and screening of new product opportunities, evaluation of product performance, segmenting the product market, diversification and simplification of the product line, and the management of innovation. *Prereq.: MKT 3812.*

MKT 3926 Advertising Management

Management of the advertising function from the perspective of users such as product managers. Case studies and text materials explore the role of advertising, target market identification, creative strategies, media planning, and advertising evaluation. Emphasis is placed upon the coordination of advertising with other elements of the marketing mix and overall corporate strategy. *Prereq.: MKT 3812.*

MKT 3931 Marketing Research I

Major methods of marketing research are discussed. Emphasis is placed on research design issues — sampling, data collection procedures, and questionnaire construction — rather than on data-analysis procedures. Sources of error in surveys are also examined in detail, along with the appropriate methodological techniques designed to reduce their magnitude. Surveys are evaluated in terms of their ability to provide quality information. The course complements material presented in HRM 3963. *Prereq.: MKT 3811 and MSC 3802.*

MKT 3932 Marketing Research II

This course focuses on various statistical methods of design and analysis in marketing research. Among the topics discussed are nonparametric statistics, experimental design, correlation and regression analysis, multiple discriminant analysis, and factor analysis. Canned statistical programming routines will be used with actual survey data to illustrate the application of the methods discussed. This course may be taken independently of MKT 3931. *Prereq.: MKT 3811 and MSC 3802.*

MKT 3934 New Product Development

The importance of new products to the survival and prosperity of firms increases as product life cycles become shorter; as technology, competition, and consumer tastes change; and as operating costs increase. For most firms, coping with the problems of environmental change through modification of the product line is vital and difficult. This course will have as a primary concern the examination and analysis of some of the problems firms face in directing and managing their new product development activities. *Prereq.: MKT 3812.*

MKT 3936 Retail Management

This course analyzes the evolution of retail institutions and examines selected major strategy and pol-

icy problems of food, apparel, and general merchandise retailers. Cases and issues are explored from the viewpoint of the managements of super-market, department store, specialty store, and discount enterprises. Designed primarily for students interested in retailing and those concerned about the role of mass distributors and the marketing of consumer goods. *Prereq.: MKT 3812.*

MKT 3940 Defense Marketing

This course will be conducted in a seminar format. Emphasis will be placed upon defense marketing in its totality, including analysis of participant roles, contractual foundations, contractor performance, and marketing activities. Topics include the overall defense acquisitions process, market characteristics, program management, procurement methods, sales and negotiation techniques, and related marketing management factors. *Prereq.: MKT 3812.*

MKT 3941 Industrial Marketing

The problems of industrial concerns in marketing products and services to industrial, business, and organizational customers. Emphasis is placed on determining customers' needs and on developing programs to satisfy these needs. Topics include the roles and responsibilities of the marketing executive engaged in industrial distribution, advertising, and research, as well as roles and responsibilities of industrial salespeople, sales supervisors, and selling agents. *Prereq.: MKT 3812.*

MKT 3945 Sales Management

Designed to help develop the decision-making skills necessary to build and maintain an effective sales organization. Cases and readings are used to examine the strategic and operating problems of the sales manager. Major topics are: (1) the selling function, (2) sales management at the field level, (3) the sales executive, and (4) sales and marketing management. *Prereq.: MKT 3812.*

MKT 3966 Marketing in the Service Sector

Deals with public and private profit and nonprofit institutions which market services. Types of organizations covered include insurance, transportation, utilities, entertainment, health care, education, religious, sports, banking, artistic, and protective. Case discussions, textbooks, and outside readings are combined for a balanced approach for the development of marketing skills. Service characteristics are defined, classified, and analyzed from the perspective of their effect on marketing methods and institutions. *Prereq.: MKT 3812.*

MKT 3978 Competitive Strategy

This course is the capstone course for graduate students emphasizing the marketing area in their studies. The course pulls together into a cohesive whole the various functional, institutional, and strategic elements which comprise marketing and to which the student has been exposed in his previous course work. *Prereq.: MKT 3812.*

MKT 3980 Marketing Information and Decision Support Systems

This course is structured around the use of state-of-the-art information systems and computer-based decision aids in all areas of marketing management. It does not cover the traditional areas of marketing research. Hands-on experience with information systems and decision aids in the context of case studies is emphasized. *Prereq.: MKT 3811.*

MSC 3531 Advanced Concepts in Information Systems

This course considers a number of significant developments in information systems, and examines their impact on present and future management. Typical coverage may vary from quarter to quarter, but will come from the following list: office automation, software project management, fourth generation languages, expert systems, information centers, micro computers, and data communications. *Prereq.: MSC 3932.*

MSC 3750 Competitive Decision Making

The objective of this course is to acquaint the student with problems of decision making in competitive and conflict situations — situations where the behavior of competitors or adversaries should effect decisions. In addition to studying the basic theoretical results in the relevant fields, students will participate in numerous out-of-class negotiation exercises in which real competitive business situations are simulated. Through these exercises, students will have the opportunity to gain experience in making rapid, but calculated decisions in situations characterized by high degree of uncertainty and sophisticated competitors. *Prereq.: 15 q.h. of grad. credit.*

MSC 3780 Operations Management in the Health Care System

Recommended for students whose career goals are positions of responsibility in the management of the health care system. Objectives are: (1) to help provide a basic understanding of operations management problems existing in the health care system; and (2) to develop decision-making ability to deal effectively with these problems. Topics include the fundamentals of management in the health care system, organizational planning, operations planning and control, utilization of resources, and policy considerations in effective and efficient operation of the health care system. Cases, readings, and field project. *Prereq.: MSC 3806.*

MSC 3802 Quantitative Analysis I

Examines the process of statistical inference, whereby the analyst is enabled to infer or draw conclusions about the parameters of a large data set on a basis of sample statistics. Other topics include the generation of subjective probabilities, the revision of probabilities to incorporate new information, and the incorporation of probabilities into the decision-making framework. *Prereq.: none.*

MSC 3803 Quantitative Analysis II

Introduction to the theory and practice of management science. Regression analysis, linear programming, and simulation are discussed in text and case material. Emphasis is on practical application of the techniques. Issues of problem definition, model building, relevant cost determination, solution generation, and implementation of results are considered. *Prereq.: MSC 3802.*

MSC 3805, Operations Management MSC 3806 I, II

The objectives of this two-course sequence are (1) to help develop an understanding of the management of operating systems, design, operation, control, evaluation, and modification; (2) to help increase the student's decision-making capabilities in technical areas; and (3) to help develop an appreciation for the operations manager's job. Topics include design of product and process, capacity planning, line balancing, work measurement, job evaluation, network scheduling, production planning, inventory management, production scheduling and control, and quality control. Operations Management I concentrates on the design of the operating system; Operations Management II focuses on its operation and control. *Prereq.: (for MSC 3806) MSC 3803.*

MSC 3909 Quality Planning and Analysis

Quality decisions take on strategic importance that must be addressed at all stages in the design and delivery of a product or service. This course analyzes the decisions that affect quality as a product passes through four distinct but interrelated stages: product design, process design, manufacturing, and sales-service. Course material emphasizes how decisions concerning quality influence the competitive position of an organization. Recommended for students who are interested in any phase of product (service) delivery, such as new product design, marketing, sales, manufacturing/operations, and strategic planning. Both text and case material will be used. *Prereq.: MSC 3806.*

MSC 3911 Manufacturing Policy

Focuses on strategic operating decisions typically addressed by the vice president of manufacturing operations, such as capacity expansion, the impact of new products and/or processes, product allocation to plants, and vertical integration. The emphasis will be on how these decisions impact the competitive position of a firm both now and in the future. This emphasis helps the students understand the totality of a top management situation where the interactions between corporate and manufacturing strategies are most evident. Learning materials include case studies, reference notes, and articles. Recommended for students who currently are in, or expect to be in, positions of major responsibility in manufacturing/operations, and also for students who must possess the qualifications to analyze the man-

ufacturing capabilities of companies, such as those in investment banking, finance, and consulting. *Prereq.: MSC 3806.*

MSC 3913 Operations Management in the Service Sector

Traditional courses in operations management usually deal with manufacturing, because the concepts and techniques of operations management were originally developed in manufacturing settings. However, as the service and nonprofit sectors of the economy gain in importance, they have greater need for the types of tools and techniques which manufacturing uses. This course explores the applicability of operations management techniques in non-manufacturing environments. Industries covered include food service, health care, recreation, equipment rental, retailing, banking, insurance, government services, and airlines. *Prereq.: MSC 3806.*

MSC 3923 Computer Models for Management Decision Making

This course is designed to assist students in learning the use of the computer as a decision aid, rather than simply for data processing. The objectives are to enable students to recognize the features of various decision problems which make them candidates for computer modeling, to specify the design of appropriate management science models, and to realistically interpret the output from these models. Decision problems will be drawn primarily from the production, finance, and marketing areas. Topical coverage will be determined by the instructor and will be drawn from areas such as the following: simulation, linear programming, queueing theory, risk analysis, inventory models, portfolio theory, and Markov processes. Course material will include readings, cases, and lectures. Students will use the computer extensively in their case preparations. In some instances, "canned" computer programs will be provided; at other times students may be required to write their own models in languages such as BASIC or IFPS. *Prereq.: MSC 3932 and MSC 3803.*

MSC 3928 Decision Support Systems

As the electronic data processing/management information systems field enters its second quarter century, a number of important changes are rapidly taking place: hardware prices are decreasing as power is increasing, software for decision support is finally maturing, and managers experienced in data processing techniques are rising higher in many organizations. This course is designed to acquaint the MBA candidate with current and future trends in decision support systems. Topical coverage will include: developments in hardware and software, decision support systems, high-level planning languages, and the politics and problems of systems implementation. Because this course is heavily directed toward issues of man-machine interaction and decision making, it is significantly narrower in scope than either MSC 3932 or MSC 3933. This course is usually conducted as a seminar, and registrat-

is limited. Extensive classroom participation is required. Several years of full-time work experience is high desirable, but not an absolute requirement. *Prereq.: MSC 3932 or MSC 3933.*

MSC 3929 Business Forecasting

This course addresses forecasting problems of concern to decision makers with the firm. Specifically, the course entails short-run (weekly, monthly) forecasting using time-sharing methods such as regression, exponential smoothing, and other related techniques. In addition, the course includes aggregate industry and national economic forecasting with longer time horizons. *Prereq.: MSC 3802 and MSC 3803.*

MSC 3930 Models in Operations Research

This course focuses on modeling for selected business applications using operations research/management science methodology. Emphasis will be on proper modeling and problem solving using readily available computer software. A few selected modeling techniques will be discussed in detail. *Prereq.: MSC 3802 and MSC 3803.*

MSC 3932 Introduction to Computer Applications

A business-oriented introduction to data processing functions and systems. Introduction to the history, terminology, technology, and economics of data processing hardware and software. Management issues in the design, selection, evaluation, and use of computers and computer services. Individual familiarization with elementary computer programming by using time-shared computer facilities to solve simple business-oriented exercise. *Prereq.: none.*

MSC 3933 Management Information Systems

This course deals in depth with the analysis, design, implementation, and operation of modern management information systems. Case studies are utilized as the primary vehicle to illustrate all phases in the creation and management of computer-based systems. The emphasis of the course is on management issues rather than on computer technology or programming. This course is designed to follow MSC 3932. Thus, it is the logical second computer course that an MBA candidate might take. *Prereq.: MSC 3932.*

MSC 3934 High Technology Operations Management

High technology industries are usually characterized by greater degrees of innovation, faster rates of obsolescence of both products and capital equipment, and manufacturing operations at the early phases of the learning curve. These factors must be kept constantly in focus for efficient operations. This course discusses the importance of these factors, and the application of the tools and techniques of operations management to firms operating in a high technology environment. Recommended for students interested in careers in manufacturing in high technology industries, and also for those who would analyze the manufacturing capabilities of firms vis-a-vis tech-

nology, market and environment such as analysts for venture capitalists and consultants. *Prereq.: MSC 3806.*

MSC 3936 Data Base Management Systems

This course provides a management-oriented introduction to data base management systems (DBMS). Topical coverage will include: rationale for the DBMS approach, data base design, data models, DBMS software tools, conversion to a data base environment, and the role of the data base administrator. Students will be given the opportunity to use a DBMS package, gain experience in data base design, use a query language, and develop DBMS applications. *Prereq.: MSC 3932*

MSC 3937 Simulation and Modeling

This course presents the technique of computer simulation from a management perspective. The students will be given the opportunity to learn the fundamentals of programming and modeling discrete-event digital simulations. Methodological issues such as types of simulation languages (including GPSS and SIMSCRIPT), random number generation, experimental design, and validation and verification will be considered. A survey of common simulation studies will be presented. The student will work on projects designed to provide experience in performing and evaluating various aspects of modern simulation studies. *Prereq.: MSC 3932 and MSC 3902.*

MSC 3938 Systems Analysis and Design

This course covers the systems analysis and design process from the point of view of both end user and systems analyst. Topical coverage will include the systems life cycle, the "traditional" systems analysis and design process, alternate strategies in implementing systems, the iterative nature of systems analysis and design, hardware and software evaluation and selection, and control of backlog. *Prereq.: MSC 3932.*

MSC 3939 Manufacturing Systems Software

The objective of this course is to provide the MBA student with an understanding of available manufacturing software. Upon completion of this course, the student should be prepared to participate in decision-making processes concerning manufacturing systems software. Topical coverage will include overview of manufacturing software, interfaces to other applications, micro/mini/mainframe trade-offs, cost of operations, and control of system maintenance.

Prereq.: MSC 3932.

MSC 3940 Data Communications for Managers

A non-technical introduction to data telecommunications to improve management knowledge in the many ways of handling data, both locally and remotely. Areas to be covered will include fiber optics, microwave, infrared, networking, and switching. Students will be given an opportunity to design a centralized computing system, a personal computer cluster, and, finally, the ability for the personal computers and the centralized computer to talk to each other. *Prereq.: MSC 3932.*

MSC 3941 Contemporary Issues in Manufacturing Management

This course considers recent significant developments in manufacturing technology and their managerial implications. The course objectives are to provide an understanding of modern manufacturing systems and their associated operations management problems, and to develop decision-making ability necessary for the effective management of such systems. The topics covered include: automation, group technology, just-in-time production and computer integrated manufacturing. The course involves lectures, readings, cases, and a field project. *Prereq.: MSC 3806.*

MSC 3960 Operations Planning and Control

This course examines the scheduling and control of resource allocations in operating systems. The systems range from high-volume assembly lines, to intermittent production systems to one-of-a-kind projects. Topics include: inventory planning and control, aggregate planning and master scheduling, materials requirements planning and network analyses. Both test and case materials are used. This course would be valuable to anyone interested in a career in operations management, industrial sales, purchasing, and consulting. *Prereq.: MSC 3806.*

TRN 3903 Corporate Transportation and Distribution Management

This course focuses on the design and management of corporate transportation and distribution systems. Emphasis is given to the analytical framework which is employed in making complex distribution tradeoffs. Attention is devoted to topics such as inventory control, location analysis, transportation planning, and the integration of logistics planning with other functional aspects of the organization. *Prereq.: 15 q.h. of grad. credit.*

**Boston-Bouvé College of
Human Development Professions**

Graduate School of Boston-Bouvé College of Human Development Professions

All courses carry four quarter-hours of credit unless otherwise indicated. Please see the current schedule for summer, fall, winter, and spring quarter listings.

Counseling Psychology, Rehabilitation, and Special Education

Special Education

CRS 3429 Development and Implementation of Programs for the Severely Handicapped

Course work includes observation of severely handicapped persons in the classroom and community; demonstration of evaluation and assessment techniques; and analysis of developmental, educational, and rehabilitation plans for severely handicapped persons. *Prereq.: CRS 3412 Psychology of Individuals with Special Needs.*

CRS 3428 The Severely Handicapped

A review of handicapping conditions and consideration of the implications of severe multiple handicaps. Students will develop a case study of a severely handicapped person in conjunction with a review of relevant literature. *Prereq.: Permission of the instructor.*

CRS 3801 Thesis

A research activity that may be selected by the student in lieu of two courses (8 quarter hours), with the approval and recommendation of the adviser.

CRS 3805 Institute in Special Education

(See general institute description on page 86.)

CRS 3808 Workshop in Special Education

(See general workshop description on page 86.)

CRS 3400 Alternatives for Mainstreaming Individuals with Special Needs

This course is for administrators, teachers, and specialists who are involved with mainstreaming individuals with special needs. Alternatives in decision making and program development, implementation, and evaluation may be explored with members of various disciplines who provide services for special needs children.

CRS 3401 Educating Individuals with Learning Disabilities

This course surveys behavioral and social-emotional characteristics of individuals who manifest specific defects in perceptual, integrative, or expressive processes that impair learning. Current service delivery programs, individual learning styles, and related curriculum materials for elementary through high school-aged, learning-disabled students are also analyzed.

CRS 3404 Education of Individuals with Behavioral Disorders

A study of the various theories, programs, and approaches dealing with emotional disturbance. Emphasis on the role of the educator as it relates to the therapeutic management of individuals and groups displaying problems in socio-emotional development. Parent-teacher interaction is also discussed.

CRS 3405 Group Dynamics

Emphasis on understanding group growth, behavior, and action fundamental to developing solutions to the complex developing of group life. Students are given the opportunity to learn to examine their strengths and weaknesses, to examine group leadership styles, to become alert to new ideas and actions, to discover the pulse of a group, and to analyze reasons for one group's productivity and another's nonproductivity.

CRS 3406 Mental Health

Study of conditions leading to optimal social adjustment. Consideration of the relationship between the maturation process and mental health, possible predeterminants of maladjustment, and factors which encourage the attainment of emotional maturity. Special emphasis is on the role of the school. Contributions from the fields of psychiatry, psychology, sociology, physiology, and medicine may be synthesized and evaluation.

CRS 3407 Case Conferences: Individuals with Special Needs

This course is conducted as a seminar in connection with the student's practicum. Case presentations by outstanding resource persons are thoroughly examined and discussed. Students will also be expected to make their own case presentations to the seminar. *Prereq.: ED 3306 Abnormal Psychology and CRS 3404 Education of Individuals with Behavior Disorders.*

CRS 3408 Socio- and Psychodynamics of Family Life

Consideration is given to the internal and external dynamics of family life and the significance of such dynamics to the mental health of handicapped individuals and their families. Emphasis is on the impact of disability on family functioning and integra-

tion. Approaches to working with parents of special needs groups may be explored from psychodynamic, social learning, and systems viewpoints.

CRS 3409 Seminar: Problems of the Behaviorally Disordered

This course provides an intensive study of the special problems of the behaviorally disordered child. It gives seminar students the opportunity to proceed in depth in areas of special interest. Special attention focuses on problems presented by the autistic child, the neurotic child, the child with character disorders, the child with psychosomatic disorders, and the multihandicapped child. *Prereq.: CRS 3424-CRS 3425 Etiology and Development of Special Needs.*

CRS 3410 Review of Current Methodology and Research in Learning Disorders

This advanced course is designed to help develop the following competencies in relation to educating learning-disordered individuals (early childhood through adulthood): use of task analysis and learning style to develop comprehensive individual education plans (refinement of skills developed in CRS 3409); use of current research to evaluate techniques of intervention (e.g., behavior modification and drug therapy for hyperactive children); review of current research to evaluate assessment techniques (e.g., effectiveness of available tests for learning disorders; ability to administer, score, and interpret tests useful in identifying learning disabilities; use of prescriptive techniques and materials for learning disabilities). Selection of topics within competency areas may be individualized for students, based on previous course work and experience. *Prereq.: CRS 3401 Educating Individuals with Learning Disorders and ED 3342 Research Design in Education.*

CRS 3411 Development and Implementation of Programs for Learning Disorders

This advanced course helps to develop required skills for resource room and diagnostic-prescriptive teachers and special needs consultants to the regular classroom. Projects for the course include needs assessment for various special needs programs, development of a screening and diagnostic test battery, development of a diagnostic-prescriptive procedure for a specific population, development of in-service programs, development of a plan for educational group management. Projects may be selected by students according to their particular needs. Students in this course should be experienced in working with individuals with special needs. *Prereq.: CRS 3401 Educating Individuals with Learning Disorders and CRS 3415 Assessment in Special Education, and CRS 3416 Diagnostic-Prescriptive Teaching.*

CRS 3412 Psychology of Individuals with Special Needs

A study of the social and emotional adjustment of the handicapped and of the psychological significance of mental, sensory, and motor variations. The effects of limitations imposed by attitudes of society, the attitudes of individuals toward their handicaps,

and the effect of the handicap itself are evaluated. Implications for educational programs are analyzed. (This course should be among the first taken in the Special Education sequence.)

CRS 3413 Evaluation and Education of the Vocationally Handicapped

Designed to develop fundamentals skills in the evaluation and teaching of activities related to the vocational development of disabled individuals. Work sample and other techniques are used to assess levels of skills. Focus is on activities such as home management, use of tools, household repairs, basic sewing, essentials of food preparation, and activities of daily living (ADL). Visits may be made to sheltered workshops and vocational adjustment centers.

CRS 3414 Rehabilitation and the Special Education Teacher

This course is designed to deal with effective working relationships between rehabilitation professionals and special education teachers. Elementary and secondary school personnel concerned with children with special needs will also find the course pertinent. Consideration is given to current legislation (Massachusetts Chapter 766) and its implementation, the teacher's role in rehabilitation, understanding of the total rehabilitation process, and rehabilitation resources available to school personnel.

CRS 3415 Assessment in Special Education

This field-based course offers students the opportunity to learn to administer selected norm-referenced tests for special needs populations, determine which tests will yield the most information in a variety of case studies, and interpret data obtained from a minimum of four norm-referenced test batteries.

CRS 3416 Diagnostic Prescriptive Teaching

Course instruction in this field-based course focuses on the following broad areas: development and implementation of individualized educational plans, including tasks analysis, annual goals, and short-range objectives; educational strategies and their application in classroom management; adaptation and selection of materials and strategies in various academic areas; perceptual-motor skills; and social-emotional interventions.

CRS 3417 Early Childhood Learning Problems: Identification and Program Development

Informal and formal screening and assessment procedures suitable for an early childhood population are evaluated. Students will be required to work with young children in order to acquire experience with screening and assessment techniques. The resulting information may then be used to develop programs to meet the needs of individual children. *Prereq.: CRS 3415 Assessment in Special Education.*

CRS 3418 Special Education for Gifted Children

Identification, characteristics, and problems of gifted, creative, and talented children and youth. Emphasis on administrative and instructional adjustments needed to provide for this group of exceptional children.

CRS 3419 Fieldwork and Seminar with Special Needs Children**CRS 3420 Student Teaching and Seminar with Special Needs Children (4 Q.H. each)**

The courses are scheduled to extend over a full year in a series of experiences as observer, tutor, and teacher. Students must make available approximately 250 hours or two days per week for two quarters for fieldwork, then approximately another 250 hours or four days per week for one quarter for student teaching. Students who are employed and who cannot devote full days to satisfy these requirements must arrange to be available evenings, weekends, and summers. Provision for attendance at biweekly seminars must also be made. Seminars are for the purpose of discussing with other students and professors the relevant issues confronted by teachers of special needs children. Outside speakers and programs may be arranged to extend this dialogue. The adviser's written approval will be required before the student can do field placement or student teaching. The adviser's written approval is also required before students can obtain a waiver of student teaching.

All students, regardless of past experience, certifications, or letters of approval, are expected to do approximately 250 hours of fieldwork, set up and supervised by the University.

CRS 3421 Fieldwork and Seminar**CRS 3422 Practicum in Special Education (4 Q.H. each)**

The practicum is designed to satisfy department requirements for field experience and extended practicum for SECP or other students who do not need certification. It extends over a full year and covers a series of experiences. Students must make available a minimum of two days per week for the first two quarters and five full days per week for the third quarter. Application for field placement is made two quarters prior to that for which fieldwork is planned. Part-time students who are employed will need to make provision for a full quarter of fieldwork, five days per week, and for evening, weekend, or summer assignments to satisfy the requirement for field experience. Provision for attendance at seminars must also be made.

CRS 3424, 3425 Etiology and Development of Special Needs (8 Q.H.)

The first quarter (CRS 3424) concentrates on factors which primarily affect deviations in cognitive, motoric, and physical development. Understanding of these factors will be used to discuss multi-disciplinary life-management issues relating to Down's Syndrome, cerebral palsy, and other common conditions.

The second quarter (CRS 3425) concentrates on factors which primarily affect emotional development. Psychobiological, psychodynamic, and learning theory approaches may be discussed and related to problems of lifespan management. Community programs in addition to the more traditional intervention techniques are analyzed.

CRS 3426 Seminar in Mental Retardation

A study of research in the field and its implications for teaching. Intervention strategies are studied and evaluated.

CRS 3427 Seminar: Neuropsychology of Learning and Behavior Disorders

Through critical review of the literature, varied neuropsychological interpretations of the nature of learning and behavior disorders are analyzed and discussed. Topics related to the function of the brain and its relationship to behavior include biochemical and physiological correlates, cognitive and perceptual factors, genetic and maturational variables, hemispheric specialization, and implications of drug studies. Implications of the above for educating and serving special needs individuals are useful to administrators, teachers, counselors, reading specialists, school psychologists, and those in allied health fields. Students will be expected to give a presentation in an area of interest related to the seminar topic. *Prereq.: CRS 3401 Educating Individuals with Learning Disorders, CRS 3424 Etiology and Development of Special Needs, SLA 3604 Language Disturbances in Children, and/or permission of instructor.*

CRS 3800 Directed Study

This experience is provided for the student whose unique academic needs or interests cannot be adequately satisfied in any of the scheduled courses of the department. Not available to special students. *Prereq.: Approval of the chairperson of the department and of the director of the graduate school. (Approval forms must be submitted during the quarter prior to registration for the Directed Study.)*

Rehabilitation Administration**CRS 3437 Community Planning in Rehabilitation**

What administrators need to know about community planning to develop programs in their areas. Basic principles of community planning, organization, and dynamics, as well as interdisciplinary relations in rehabilitation. Examples of community planning from different rehabilitation agencies and the referral process among these agencies will be studied.

CRS 3438 Federal-State Relations in Rehabilitation

The complex network of federal-state relations and their implications for rehabilitation. Grant procedures, matching formulas, public relations and RSA directives, state and federal legislation pertinent to rehabilitation.

CRS 3439 Social Welfare and Rehabilitation

This course attempts to acquaint administrators, counselors, and other human services personnel with the broad field of social welfare. The course reviews the historical background of the relationship between vocational rehabilitation and social welfare and the more recent developments in the relationship of these fields.

CRS 3440 Program Evaluation in Rehabilitation

The emphasis in this course will be on administrative research, program evaluation, grantsmanship, etc. In addition, students will have the opportunity to develop a research design on some aspect of rehabilitation administration and carry out the necessary research operations involved.

CRS 3442 Fiscal Policy and Management I

An introduction to the concept of fiscal and managerial control. Areas to be covered may include accounting and budgetary procedures, need surveys, goal-setting practices, recruitment, staffing, training, professional development, caseload management, program planning, utilization of research, leadership patterns, performance appraisal, and external relationships. Case method approach may be used in classroom exercises.

CRS 3443 Administration of a Sheltered Workshop

Special problems of administering a sheltered workshop, such as community planning, work evaluation, job training, labor relations, contracting, production, and occupational placement.

CRS 3477 Evaluation of Deaf Rehabilitation Clients

Methods and techniques of psychological and vocational evaluation for deaf rehabilitation clients, including evaluation of client biographical characteristics, evaluation interview, and psychometric assessment. Required of all students in Deafness specialization of Rehabilitation Counseling program. *Prereq.: CRS 3501 Psychological Testing and SLA 3644 Foundations of Deaf Education.*

CRS 3449 Psychological Problems of Disability

An advanced course in psychopathology as it relates to the impact of disability on personality. In-depth study of the moderately and severely handicapped from the viewpoint of psychosocial factors, interpersonal relationships, and cognitive versus noncognitive functioning in those with motor and sensory disabilities, problems of dependency and motivation; role of psychosomatic factors. Some discussion of the role of treatment and rehabilitation.

CRS 3454 Rehabilitation of the Geriatric

This course presents a comprehensive treatment of the problems, dimensions, and parameters involved in the administration of the various services and facilities for the rehabilitation of the geriatric. Special emphasis is on the philosophy of rehabilitation versus disengagement.

CRS 3455 Critical Issues in Rehabilitation Administration

This course is built around the exploration and in-depth discussion of current issues which are highly problematical to the field. Among these issues are the breadth of the concept of disability, appropriate training sequences for the various rehabilitation disciplines, resolution of conflict over role overlap among disciplines, appropriate models for service delivery

systems. The most current and relevant research may be brought to bear upon these areas, as well as knowledge from the reservoir of experience of instructors, visiting experts, and the student participants themselves. Students will be exposed to the issues as they exist in the profession and in the community. A theoretically oriented frame of reference will be brought to bear upon problems when feasible.

CRS 3801 Thesis

A research activity that may be selected by the student in lieu of two courses (8 quarter hours), with the approval and recommendation of the adviser.

CRS 3809 Doctoral Dissertation

Prereq.: Admission to candidacy in the Doctor of Education degree program.

CRS 3804 Institute in Rehabilitation Administration

(See general institute description on page 86.)

CRS 3807 Workshop in Rehabilitation Administration

(See general workshop description on page 86.)

CRS 3800 Directed Study

This experience is provided for the student whose unique academic needs or interests cannot be adequately satisfied in any of the scheduled courses of the department. *Not available to special students. Prereq.: Approval of the chairperson of the department and of the director of the graduate school. (Approval forms must be submitted during the quarter prior to registration for the Directed Study.)*

CRS 3433 Introduction to Rehabilitation

An overview of an orientation to the field of rehabilitation, including its historical development, legislative involvement, psychological implications, and sociological dimensions. Emphasis is placed on coordinating and integrating services as they related to the field of rehabilitation as a community process.

CRS 3434 Principles of Medical Rehabilitation

The wide spectrum of disabilities that could profit from rehabilitation, including orthopedic, neurological, medical, surgical, and mental disabilities. The course may also present basic principles of medical rehabilitation that administrators should know. Psychological aspects of disability also discussed.

CRS 3435 Program Development in Rehabilitation

This course deals with the use of the rehabilitation model in program development for the physically handicapped, mentally retarded, emotionally disturbed, aging, welfare populations, youthful offenders, culturally disadvantaged, and other special community groups. Emphasizes the administrative involvement in developing and supporting the diagnostic, evaluative, counseling, and placement procedures used in such rehabilitative programs. Issues involving clinical program planning may be explored.

CRS 3436 Organization and Administrative Theory

The body of conceptual knowledge regarding organizational and administrative theory will be examined. Formal and informal organizations, organizations as social systems, status and role concepts, leadership in organizations, power structure, relationships to authority, decision making, and communication in and between organizations. An organizational analysis will be made of all the different types of rehabilitation settings currently in use.

CRS 3441 Practicum in Rehabilitation (8 Q.H.)

Students are usually assigned to a variety of rehabilitation agencies for their practicum experience. Problem solving relevant to experiences encountered in internship. A seminar may be regularly conducted by a senior faculty member in conjunction with the practicum experience. This seminar offers students an opportunity to share their field-work experiences and resolve problems in rehabilitation which are connected with their field-placements. (Two sections of this practicum are offered—one for those majoring in Rehabilitation Administration and one for those majoring in Rehabilitation Counseling.)

CRS 3444 Fiscal Policy and Management II

Understanding the fiscal management of the typical rehabilitation setting, including basic rehabilitation agency accounting, planned program budgeting, disbursements, cost analysis, contracting, taxation, forecasting, and funding. The implication of data processing for fiscal management is covered in the course. Special problems will be assigned during the course.

CRS 3445 Legal Aspects of Rehabilitation and Special Education

This course is designed to sensitize rehabilitation administrators, special educators, rehabilitation counselors, and other personnel to the impact of legislative developments upon the field of rehabilitation and special education. Special emphasis is placed on understanding the legal implications for rehabilitation of the latest Vocational Rehabilitation Administrative Amendments, workmen's compensation laws, eligibility determination criteria, and Social Security Amendments. Latest federal and state special education legislation is covered.

CRS 3446 Occupational Placement

A study of the dynamics of moving the rehabilitation client into the world of work within the framework of the specific community structure. Development of facility in use of resource materials in occupational information, job description and analysis, performance appraisal, training, and vocational assessment. The personnel point of view of the handicapped individual is discussed and analyzed, and more effective placement practices developed.

CRS 3448 CAGS Rehabilitation Practicum

Students are usually assigned to rehabilitation agencies, where they are expected to spend 250 clock hours under appropriate supervision. A seminar with regular faculty members is conducted twice each quarter.

CRS 3450 Administrative Problems in Rehabilitation

Seminar designed to analyze, in depth, critical issues and selected rehabilitation problems. Operations and systems research as applied to rehabilitation will be highlighted. Students are offered the use of institute research studies and studies available through social and rehabilitation services, completed research, and demonstrative projects.

CRS 3451 Essentials of Case Management and Supervision

The relationship between case management and case-work supervision. Topics are the dynamics of the communication process, decision making, conflict, resolution and compliance, management of resources external to the organization, structural and functional analysis of supervisory process, and caseload management.

CRS 3452 Rehabilitation of the Alcoholic and Drug Dependent

A study of comprehensive factors, including the nature of etiology dynamics involved in alcohol and drug dependency; techniques for evaluation; rehabilitation administration, planning, and treatment.

CRS 3453 Rehabilitation of the Penal Offender

The rehabilitation of the penal offender is examined from an eclectic point of view. Psychodynamic elements are stressed, as well as social factors in the etiology, evaluation, and treatment and rehabilitation seminar planning and administration.

Counselor Education

CRS 3500 Foundations in Professional Psychology and Human Services

The purpose of this course is to provide a philosophical and theoretical background for beginning graduate students in counseling. The course has three objectives: 1) to sharpen the "self as instrument" through study and discussion of established theories of helping related to one's personal value system and through self-exploration and increased self-understanding in heretofore unexplored personal areas; 2) to introduce students to the broad spectrum of professional helping service areas with the intent of clarifying the students' professional roles; and 3) to begin to promote the development of a professional identity as a psychological helping professional.

CRS 3501 Psychological Testing

The principles and problems of psychological testing as applied to the work of the counselor are discussed. Consideration is given to technical concepts applicable to the use, understanding, and interpretation of test scores. Students have the opportunity to become familiar with the most frequently used tests of intelligence, aptitude, achievement, interest, and personality. Tests are evaluated for use in diagnosis and in understanding human behavior, with emphasis on their interpretation.

CRS 3502 Vocational Development and Occupational Information

A dual-emphasis course dealing, first, with theories about the ways in which individuals make decisions concerning their choice of vocation; and second, with the kind of data which are needed to assist people with these decisions. These requisite data deal with the relationship of social and economic change to occupational trends, the classification and description of occupational fields, methods of collecting, evaluating, filing, and disseminating vocational information, and the role of the counselor in fulfilling these functions.

CRS 3503 Counseling Theory and Process

A course which normally is taken in the fall quarter, concurrently with the beginning of Practicum. The course will provide the student with a basic cognitive understanding of several major theoretical approaches to counseling. Classroom content will help students to become familiar with a wide range of individual counseling strategies, to develop listening, understanding, and communications skills, and to further probe their own self-understanding as counselors. These skills and understandings will be discussed and simulated in the context of a variety of settings with a variety of clients. Role playing, case material, and audio and video materials will be utilized in the instruction. This course may be selected by degree candidates in other departments in any quarter except the fall quarter.

CRS 3504, 3505 Counseling Practicum I and II

The counseling practicum is a supervised counseling experience extended over the academic year. Registration for this course occurs only during the fall and spring quarters. Emphasis in the fall will be on small-group seminars dealing with counseling and other related matters. The winter and spring quarters will concentrate on the supervised counseling assignment. Assignment to practicum settings will be made according to the student's major area of concentration. Students must make themselves available a minimum of two days per week during the academic year (October to June) for placement in a field setting. Seminars will stress material germane to the student's major and will meet a total of twenty-four times during the year. CRS 3504 must be successfully completed prior to commencing CRS 3505. (For administrative purposes, these practicum course numbers will apply to each of the following specific practicum placements: School Practicum (N-9, 5-12), Counseling Psychology, Career/Industrial, Student Personnel/College Practicums.)

Part-time students must submit an application for practicum (available from the department) by April 1, for approval to enroll in the practicum the following fall quarter. *Prereq.: CRS 3500 Foundations in Professional Psychology and Human Services and CRS 3503 Counseling Theory and Process, both of which may be taken concurrently with the beginning of practicum.*

CRS 3507 Group Counseling

An introduction to theory, principles, and techniques of counseling with groups of individuals at different levels of development and for varying purposes. A basic mode of approach may be to involve students in a genuine group counseling experience in order to understand the phenomenon of group experience. *Prereq.: CRS 3503 Counseling Theory and Process.*

CRS 3508 The College Student and the Campus

The relationship between college students' behavior and their environment is examined, with focus on students' rights, their social-emotional developmental concerns, and their search for identity. The impact of societal forces and nontraditional patterns of learning on college curriculum options is examined, and varying concerns of personnel services in different types of college climates, including the community college, are discussed. Current issues in higher education are examined as they relate to services offered to students.

CRS 3513, 3514 School Psychology (8 Q.H.) Fieldwork I and II

The first phase of a two-year sequence of supervised fieldwork required for school psychologist certification. Students are assigned a placement in an N-12 school system working under the supervision of a certified school psychologist. The activity of the fieldwork will extend for two days a week across the academic year from September to June. Students perform psychological evaluations and participate in other appropriate activities. Seminars meet for twenty-four sessions during the year to provide skill training and discuss role functions. Students receive one hour of supervision per week from the field site supervisor. Students must submit an application for a fieldwork placement by April 1 for approval for the course which begins in the following fall quarter.

CRS 3515, 3516 School Psychology (8 Q.H.) Fieldwork III, IV

The second phase of a two-year sequence leading to eligibility for application for school psychologist certification. The student will be assigned typically to a different N-12 grade placement than the first experience to provide a diversified experience. The placement is for two days per week from September to June. Seminars meet twenty-four times across the academic year and consist of case presentations, skill and strategy training, and discussions of case management. Students work under and receive one hour of supervision from their certified school psychologist site supervisor. Students must submit an application for fieldwork by April 1 for approval to enroll in the fieldwork course the following fall quarter. *Prereq.: CRS 3513, 3514, School Psychology Fieldwork I and II.*

CRS 3517 Consultation Seminar

Offers a review of various consultation models, including behavioral consultation, process consultation, and systems consultation. Study also examines current

research in the field of counseling consultation. Particular emphasis is placed on the development of a personal consultation style and enhancement of consultation skills.

CRS 3518 Career Counseling Seminar

Study focuses on three types of counseling experiences: career-education program planning, leadership of career-development groups, and vocational counseling. Learning activities include case studies and audiotapes of career counseling sessions, class discussions of local problems and their solutions, didactic instruction, and the implementation of an actual career-education program relative to the student's area of interest.

CRS 3525 Family and Parent Counseling

The focus of this course is on a conceptual understanding of family systems theory and its application to and implications for family counseling. Structural, communicative, and strategic approaches to marital, parent, and family counseling are presented as the family is studied as an interactional system, as a seedbed of distress and health. Students have the opportunity to become familiar with family assessment, counseling skills, and strategies. *Prereq.: CRS 3503 Counseling Theory and Process.*

CRS 3526 Seminar in Student Personnel Work

Relevant topics and cases for personnel workers and administrators in higher education will be discussed and studied in depth. Particular emphasis is placed upon the development of student personnel programs, budget planning and development, and staff relationships. The expertise of appropriate specialists is utilized.

CRS 3527 Counseling Strategies for Children and Adolescents

Intended primarily for students who will counsel in school settings or other settings emphasizing work with children and adolescents. A broad range of approaches will be considered, including, but not limited to, behavior modification, Gestalt, and Adlerian strategies. Special emphasis will be placed on the development of strategies designed to help alleviate typical school-related and developmental problems such as nonachievement, decision making, negative self-identity, and disruptive behavior. Consideration will also be given to the counselor's role as a consultant to teachers, parents, and administrators in effecting positive behavior change. *Prereq.: CRS 3503 Counseling Theory and Process.*

CRS 3528 Vocational Counseling Strategies

The individual's role expectations in the world of work will be examined from a human development perspective, and a systematic program to foster self-awareness will be set forth. Vocational counseling is viewed as dealing with the entire individual, including his or her values, underlying psychological needs and drives, and the influence of the environment on his or her level of development and career awareness. Other topics to be developed in this course will include counseling with females and nonachievers, the decline

of the work ethic, community resource development, job placement, and information giving as a perceptual process. The course is intended for a variety of client populations from adolescence through adulthood. *Prereq.: CRS 3503 Counseling Theory and Process.*

CRS 3529 Rehabilitation Counseling Strategies

Primary emphasis will be on the roles and functions of the rehabilitation counselor, relevant issues in the field, and an overview of the rehabilitation process. Special problems and techniques of counseling with the disabled (physical, mental, and behavioral disorders) will be examined through case studies and role playing. Discussion will also cover disability in the context of social deviance and psychosocial approaches to understanding human behavior, including self-concept, social role theories, and rational-behavioral approaches. *Prereq.: CRS 3503 Counseling Theory and Process. (This prerequisite is waived for Rehabilitation Administration majors.)*

CRS 3530 Psychological Counseling Strategies

Focuses on a variety of strategies designed to alleviate problems of older adolescents and adults. Developmental and perceptual Gestalt insight approaches and behavioral approaches to counseling will be analyzed for their effectiveness with a variety of psychological problems. This course is primarily intended for the student working with client populations in mental health settings and college counseling centers. *Prereq.: CRS 3503 Counseling Theory and Process.*

CRS 3531 Case Studies in Marriage and Family Counseling

An advanced-level course for students with previous experience or preparation in marriage and family counseling. Skills to be emphasized may include 1) the preparation of case studies of family and marriage histories and current functioning; 2) the design of service, counseling, and referral programs based upon comprehensive studies of needs and resources; and 3) the practice of counseling strategies through role playing, taped interviews, and progress reports of current counseling activities. *Prereq.: CRS 3525 Family and Parent Counseling.*

CRS 3532 Seminar in School Psychology

This course provides an intensive analysis of philosophical, technical, and school administrative issues contributing to the professional identity and consultative function of the psychologist in an educational milieu. Simulations, case studies, and research projects will be used to study these issues. *Prereq.: Permission of instructor.*

CRS 3533 Psychoeducational Prescriptions

Recommended for all school counseling majors and required of all school psychology majors, this course will provide training and supervision in synthesizing data on a student's cognitive, affective, and interpersonal needs with educational plans which 1) are based directly on that data, 2) may be implemented in the school setting, and 3) meet the 766, PL 94-142 criteria for such plans. *Prereq.: Permission of instructor.*

CRS 3534 Individual Intelligence Testing (6 Q.H.)

Preparation to administer, score, and interpret the Stanford-Binet Intelligence Test, the Wechsler Adult Intelligence Test, and the Wechsler Intelligence Scale for Children. Consideration will be given to the theories of intelligence upon which the tests are based and the use of the tests in educational and clinic settings. Students will be required to administer and score thirty tests, including some from each of the three tests included in the course. *Prereq.: CRS 3501 Psychological Testing.*

CRS 3535 Seminar in Contemporary Issues in Counseling

Intensive study of a selected topic in counseling such as counseling minorities, current research, sex counseling, transactional analysis theory and practice, and behavioral counseling. Course objectives will vary according to the topic but may include a review of the literature, skill building workshop, and action projects. *Prereq.: CRS 3538 Advanced Theories of Behavior Change and/or permission of instructor.*

CRS 3536 Advanced Group Counseling

This course will be a continuation of the content presented in Group Counseling, placing greater emphasis on developing skill in conducting group counseling at a variety of age levels. Greater attention will be given to relevant readings and research on group process and methods for behavior modification. *Prereq.: CRS 3507 Group Counseling.*

CRS 3537 Seminar in Counseling Supervision and In-Service Education

Theory and practice of the supervisory process as it applies to the evaluation of counselor effectiveness and professional development. Theory readings, discussions, role playing, and a written plan for in-service staff development are course requirements, but the major activity of the course involves the use of audio and videotapes of actual supervisory sessions conducted by class members. *Prereq.: Master's degree in guidance or permission of the instructor.*

CRS 3538 Advanced Theories of Behavior Change I

An advanced-level counseling course required of all CAGS students and designed to provide greater depth of cognitive understanding of three major approaches to therapeutic practice, i.e., the behavioral, depth psychological, and general systems viewpoints. Original readings from selected principal theorists will be required. The course will compare assumptions, goals, and strategies of the theorists studied in order to build a strong conceptual basis for a counseling eclecticism from these analyses. Some of the theorists studied may include Skinner, Wolpe, Bandura, von Bertalanffy, Adler, Jung, and Rank. *Prereq.: At least two counseling courses emphasizing both theory and process.*

CRS 3539 Advanced Theories of Behavior Change II

This course addresses the fundamental methods for constructively improving human behavior, as implicit within the three generic approaches to psychological

theory construction, and provides an overview of Ludwig von Bertalanffy's general systems concept of psychology and its relations to allied sciences. The course is based on a format of selected readings, lectures, and student discussion. *Prereq.: CRS 3538 Advanced Theories of Behavior Change I.*

CRS 3540 Advanced Psychodiagnostics

This is an advanced-level course providing intensive supervision in the clinical assessment of ego functioning in children and adolescents. A rudimentary knowledge of the theory and practice of psychodiagnostics is assumed. This course will enable students to receive supervision on clinical evaluations on which they are working. A heavy emphasis will be placed on integrating data from a variety of sources and making in-depth interpretations and appropriate recommendations. *Prereq.: CRS 3839 Psychodiagnostics with Children and Adolescents.*

CRS 3541 Psychodiagnostic Measures

This is an advanced-level course in the clinical assessment of adults. The course places heavy emphasis on differential diagnosis and personality description using data from a variety of sources—interviewing, case histories, and objective and projective testing. Some of the tests typically studied in this course may include the California Psychological Inventory, Minnesota Multiphasic Personality Inventory, Bender-Gestalt and Sentence Completion Tests, Wechsler Adult Intelligence Scale, and Draw-A-Person Test. Students will be required to administer and interpret psychological test data and to report their findings in a psychological report. *Prereq.: CRS 3501 Psychological Testing.*

CRS 3542, 3510 Advanced Fieldwork (8 Q.H.)

Required of all CAGS students. Students may be assigned a fieldwork placement consistent with their major professional goals and/or the settings in which they intend to work. The activity of the fieldwork may extend across the academic year from September to June and require a minimum of one and a half days per week, or the equivalent, in the fieldwork setting. Seminars will meet, subject to change, on alternate weeks with additional individual supervision on campus. Supervision will also be provided in the field setting. Both quarters must be completed before credit will be given for the course. *Prereq.: Counseling Practicum or the equivalent in experience.*

CRS 3550 Philosophy of the Behavioral Sciences

Addresses such fundamental questions as "What is science? What are its essential methods of inquiry, particularly as they pertain to the behavioral sciences? What is the nature of knowledge gained through scientific investigation, and are there limits to its usefulness?" Participants have the opportunity to examine the natural and empirical sciences through exploring theory, fact propositions, hypothetical deductive/inductive knowledge, laws, evidence, verification, reductionism, and allied ideas. *Prereq.: ED 3342 Research Design in Education and CRS 3539 Advanced Theories of Behavior Change II.*

CRS 3801 Thesis

A research activity that may be selected by the student in lieu of two courses (8 quarter hours), with the approval and recommendation of the adviser.

CRS 3808 Doctoral Dissertation

Prereq.: Admission to candidacy in the Doctor of Education degree program.

CRS 3800 Directed Study

This experience is provided for the student whose unique academic needs or interests cannot be adequately satisfied in any of the scheduled courses of the department. *Not available to special students.*

Prereq.: Approval of the chairperson of the department and of the director of the graduate school. (Approval forms must be submitted during the quarter prior to registration for the Directed Study.)

CRS 3803 Institute in Counselor Education

(See general institute description on page 86.)

CRS 3806 Workshop in Counselor Education

(See general workshop description on page 86.)

CRS 3808 Doctoral Dissertation

Prereq.: Admission to candidacy in the Doctor of Education degree program.

CRS 3839 Psychodiagnosis with Children and Adolescents

This is an advanced-level course in the theory and practice of ego functioning in children and adolescents. Heavy emphasis is placed on the case-study method. A major goal of the course will be to conduct a psychological assessment and report the findings of this assessment in terms of cognitive, perceptual-motor, affective, cognitive, and social functioning. Students will become familiar with several methods of gathering assessment data. *Prereq.: CRS 3501 Psychological Testing and CRS 3534 Individual Intelligence Testing.*

Education

Foundations of Education

ED 3300 Psychology of Learning

The basic principles and conditions of acquisition, retention, and transfer of learning. *Suggested prereq.: A course in psychology.*

ED 3301 Psychology of Thinking

A consideration of the processes involved in cognitive organization and functioning. Topics will include language, concept formation, and problem solving. *Suggested prereq.: A course in psychology.*

ED 3302 Psychology of Personality

A systematic consideration of the personality theories of Freud, Jung, Adler, Sullivan, Horney, Cattell, Allport, Rogers, and other approaches, including the psychosomatic of Alexander and the work of Reich. Theories are considered in depth and examined for ways that contribute to an understanding of dynamic factors in personality formation. Theories and theorists are compared for a greater understanding of strengths and weaknesses. Social, cultural and philosophic questions are discussed. Implications of some of the ideas and theories for the therapeutic process will also be considered. *Suggested prereq.: At least one and preferably more courses in psychology.*

ED 3303 Theories of Developmental Psychology

The major developmental theories and related research of Havighurst, Erickson, Piaget, and others. *Permission of instructor required.*

ED 3304 Child Psychology

A review of the principles of child development from birth to preadolescence. Particular emphasis will be placed on intellectual, social, and emotional development. The theoretical formulations of psychoanal-

ysis, social learning theory, and Piaget will be discussed in the context of relevant research in these areas, as well as their educational implications.

ED 3305 Adolescent Psychology

Social, emotional, and intellectual development in the adolescent years. Problems in family relationships and in the adolescent's social environment as well as his adjustment in school. Case history material.

ED 3306 Abnormal Psychology

An historical overview leads to contemporary views on how human personality becomes disordered and maladaptive. Principal emphasis is on the development of psychopathology during the course of development, including a perspective for viewing the economy of psychological deviations. Neuroses, transient states, character disorders, sexual deviations, psychophysiological reactions, drug and alcohol addictions, and psychotic reactions, each with a clinical picture, typical course, and outcomes are considered. Some consideration is devoted to current methods of diagnosis and treatment.

ED 3307 Adult Psychology

A comprehensive view of the three major areas of adulthood (young adulthood, middle age, and old age) in a context of research findings, academic knowledge, and clinical needs.

ED 3308 Seminar in Child Development

A seminar course with emphasis on discussion of child development theories with special reference to personality and cognitive development. Critical evaluation of research related to child development theories with particular emphasis on recent trends, new approaches, and relevance to educational theories

and practices. *Prereq.: A course in child psychology or human development.*

ED 3309 Seminar in Adolescent Development

A seminar course with emphasis on discussion of major problem areas facing the adolescent in our society. Particular emphasis will be given to social and emotional development. Included will be a survey of research in such areas as psychoanalysis, social learning, morality, and delinquency. *Prereq.: A course in adolescent psychology or human development.*

ED 3310 Personality and Social Structure

Human behavior from a combined psychodynamic and sociological point of view, with special emphasis on socialization and the relations between the individual and the collectivity. The integration of relevant theories from psychology, sociology, and anthropology. *Suggested prereq.: A course in sociology, cultural anthropology, or social psychology.*

ED 3311 Sex Roles in Education

This course identifies and examines some of the major issues related to sex roles in both the formal and informal educational systems of our society. Topics that will come under special scrutiny include development of sex role patterns in the home and preschool and through children's books, games, and television programs; life for boys and girls in the elementary and high school classroom; sex bias in counseling and in vocational guidance and training; changes in traditional family roles and occupation hierarchies; assets and liabilities of coeducational and single-sex education. The course may also allow students, in small groups, to explore their own sex role attitudes and the strategies they use to socialize young people.

ED 3312 Communications Theory

An introduction to communications theory, covering models of the communication process, attitude changes, information, innovation, dissemination and flow, communication modalities, and language processing.

ED 3320 Sociology of Education

The functioning of educational institutions in their social and cultural milieu will be examined from anthropological and sociological perspectives: the school as a social system; influence of the stratification system, youth cultures, and racial antagonisms upon the educational enterprise.

ED 3321 Educational Anthropology

Examination of schooling as a particular variety of socialization, with special attention to characteristics of societies that rely heavily on formal instruction, contrasted with less deliberately patterned techniques of child rearing. Readings will be mainly cross-cultural, ethnographic, and historical.

ED 3324 Comparative Education

Introduction to education in other nations and exploration of its relationships with the political, economic, social, and cultural milieu. Selected countries in Western and Eastern Europe, South America, and Africa will be considered.

ED 3325 History of Education

An opportunity to explore some of the historical roots of contemporary educational theory and practice with a focus on selected aspects of educational history from antiquity to the present. Also an opportunity to utilize knowledge gained for the development of a personal educational position.

ED 3326 Topics in the Philosophy of Education

A study of the basic assumptions underlying statements of educational content, process, and aims. Materials to be subjected to philosophical analysis are selected from educational and philosophic writings according to themes (e.g., authority and freedom, "growth" as an educational objective, the nature of educational relationships). The themes dealt with vary from quarter to quarter, depending on the concerns and interests of students and instructor. Brief lectures, mostly discussion.

ED 3327 Seminar in Contemporary Issues in American Education

Discussion of selected issues in contemporary American education such as school desegregation, compensatory education, learning problems of the disadvantaged, professionalization of teachers, etc. Review of relevant research and opinions. The topic or topics of the seminar for a particular quarter will be announced in the registration materials distributed in advance of that quarter.

ED 3328 Education and Equality

An investigation into the reciprocal relationship between American educational institutions and the equality-inequality dimension of American social structure. Both the traditional view, which celebrates the American public school as a triumph of equalitarianism, and the revisionist view, which emphasizes inequalitarian consequences of American educational practice, will be discussed.

ED 3340 Introduction to Educational Statistics

Basic descriptive statistics for measurement and research. Topics include use of statistical notation, measures of central tendency and variability, probability and sampling techniques, theoretical distributions, linear regression and correlation, and an introduction to statistical inference. (This course, or completion of a statistics proficiency examination, is required for admission to ED 3342 Research Design in Education.)

ED 3341 Intermediate Educational Statistics

Statistical inference of normal populations and discrete data; estimation; testing of hypotheses; multiple correlation; analysis of variance and covariance; contingency; the chi-square test and other nonparametric tests. Emphasis is given to application in educational research. *Prereq.: Successful completion of the statistics proficiency examination; satisfactory completion of ED 3340 Introduction to Educational Statistics; or permission of instructor.* This course must be completed prior to doctoral candidacy.

ED 3342 Research Design in Education

An introduction to scientific methods of research in education and related fields. Stress will be placed

on critical reading and understanding of research literature, formulating research hypotheses, constructing a research proposal, and carrying out an individual or group project. This course must be included among the first six courses taken by each student. *Prep.: ED 3340 Introduction to Educational Statistics or successful completion of the statistics proficiency examination.* (Students wishing to make arrangements to take the proficiency examination should call 437-3305.)

ED 3343 Advanced Research Design

This course focuses on methodologies for collecting, interpreting, and evaluating data and deals with biases encountered in the data-collection process. Topics such as data collection and interpretation, use of sampling, analysis of variance, covariance, multiple regression, multivariate procedures, and advanced topics in scaling, semantic differential methodology, questionnaire design, interview methodology, and evaluative criteria will be featured. Students enrolling for this course will design and complete a proposal on this design for the conduct of a research project. This project may be carried out as part of research on either the master's or doctoral level. *Prereq.: ED 3341 Intermediate Educational Statistics or equivalent, or permission of instructor.*

ED 3344 Nonquantitative Research Methods in Education

Nonquantitative research methods in the human development professions. Among the topics considered are problem formulation, location and selection of data, authenticity of sources, and analysis of data by synthesis. Case-study approaches and style of writing for research proposals are also discussed. *Prereq.: ED 3341 Intermediate Educational Statistics.*

ED 3345 Nature and Theory of Psychological and Educational Measurement

An examination of the logic of measurement and the nature of human capacities, aptitudes, and abilities. Characteristics of tests, ratings, questionnaires, and similar instruments are reviewed with emphasis on their reliability, validity, and utility. Item analysis procedures and test standardization are covered.

ED 3346, 3347 Independent Research Seminars I and II (4 Q.H. each)

Focus is on the design, conduct, analysis, and reporting of data from an individual research project. This project may be original or secondary, applied, theoretical, or action research and must be substantially larger in scope than that accommodated by Directed Study. Evaluation will be based on oral and written interim reports in Seminar I and oral and written final reports in Seminar II. This course will serve as an option to the thesis requirement only for students enrolled in the master's degree program in Educational Research.

ED 3348 Research and Statistical Methods for Administrators

A study of the application of the methods of research and statistical techniques to problem solving, with specific focus on the role of research in the admin-

istrative decision-making process. The course of study may also focus on the various research designs administrators may use in their positions, such as the development of a program proposal for local, state, or federal agencies. A specific topic of practical significance in administration is to be selected by the student and a design for studying the topical problem developed. Research relevant to the topic is evaluated. *Recommended prep.: Rudimentary knowledge of research designs and techniques and an elementary knowledge of basic statistical methods.*

ED 3800 Directed Study

This experience is provided for the student whose unique academic needs or interests cannot be adequately satisfied in any of the scheduled courses of the department. Not available to special students. *Prereq.: Approval of the chairperson of the department and of the director of the graduate school. (Approval forms must be submitted during the quarter prior to registration for the Directed Study.)*

ED 3801 Thesis

A research activity that may be selected by the student in lieu of two courses (8 quarter hours), with the approval and recommendation of the adviser.

ED 3820 Workshop in Foundations of Education

(See general workshop description on page 86.)

ED 3828 Institute in Foundations of Education

(See general institute description on page 86.)

Curriculum and Instruction

ED 3400 Analysis of the Instructional Process

A consideration of the rational basis for effective teaching and the nature of the educational process. Learning theory is related to the various strategies and activities that can be implemented with a learning situation to meet the needs of the learners, including those with special needs. Alternative approaches, research results, and theoretical constructs are employed to help extend the prospective teacher's concepts of the educational process and the role of the teacher in it.

ED 3401 Fundamentals of Curriculum Development

An examination of how goals and objectives are selected and how priorities are determined. Methods of designing educational programs to meet specified goals and methods of evaluating educational outcomes in terms of the goals of the program and techniques for modifying programs in the light of such performance.

ED 3402 Methods and Materials for Teaching Children I

Teaching methods and learning materials used in teaching children in a number of educational settings. This course will help students establish objectives, plan and execute appropriate learning experiences, and evaluate outcomes.

ED 3403 Methods and Materials for Teaching Children II

A continuation of ED 3402. *Prereq.: ED 3402 Methods and Materials for Teaching Children I.*

ED 3404 Methods and Materials for Teaching Adolescents and Adults I

Consideration of specific methods and materials appropriate to teaching adolescents and adults to develop in the students an understanding of the complexities of the materials and methodology of the teaching-learning process, to encourage within students attitudes conducive to and identified with good tenets of teaching, and to foster in the students acceptance of the need to grow constantly and to be aware of the continuing development of our knowledge of the learning-teaching process.

ED 3405 Methods and Materials for Teaching Adolescents and Adults II

This course provides for the specific subject areas to be attended to. Topics covered include techniques of organizing and presenting lessons, developing teaching materials, using audiovisual equipment, developing and implementing evaluation instruments, and selecting appropriate materials within each field of interest. (15 hours of field work required.)

ED 3406 Procedures of Evaluation

Consideration is given to evaluation as a process for the improvement of learning and instruction. The course concerning itself with such topics as how to measure and evaluate effective, psychomotor, and cognitive dimensions of student growth; test construction; collecting and administering standardized tests; various bases of grading; and methods of reporting student progress.

ED 3407 Student Teaching with Related Seminar 8 Q.H.

A University-arranged practicum of observation and teaching in schools offering comprehensive programs within reasonable commuting distance of the University. Participating on a full-time basis, the student is expected to develop planning and communication abilities within his major field. Biweekly seminars at the University provide additional opportunity to analyze theory-practice relationships and to examine generic problems of teaching. *Prereq.: Course in child or adolescent psychology; successful completion of all course work in the nondegree program.* (Open only to students in the nondegree Curriculum and Instruction program.)

ED 3408 The Evolution of Curriculum Theory and Practice

Examination from a historical perspective of the curriculum of the American school as an evolutionary process resulting in part from conflict between subject-oriented and student-oriented curricula, traditionalists and revisionists, behaviorism and psychodynamism, and the interplay of forces generated by students, teachers, administrators, and other interested groups. Present curricula will be analyzed as

the outcomes of such influences and trends for future developments will be hypothesized. Hence, the course will also focus on the process of curriculum development and the product of that development.

ED 3409 Seminar in Curriculum: Alternative Designs

Identification and analysis of problems in curriculum and instruction in light of the forces affecting the curriculum with the student's area of specialization; design and implementation of solutions to such problems; evaluation and field testing, where feasible, of these solutions. *Prereq.: ED 3408 The Evolution of Curriculum Theory and Practice.*

ED 3411 Seminar in Instruction: Alternative Designs

Methods of inventing or adapting methods of teaching to make them appropriate to the demands of the curriculum, the needs of the students, the capabilities of the teachers, the expectations of the community, and the resources of the school or college. This course will help the student identify the criteria by which instructional practices may be selected, by which they may be evaluated, and by which they may be developed. Instructional practices include methods of teaching, designing learning materials, grouping students, pacing, scheduling, and evaluating. Students will have the opportunity to revise existing resources and to create new resources for instruction in order to make the implementation of a specific curriculum more effective. *Prereq.: (except for students in joint programs with a department in another college): ED 3409 Seminar in Curriculum: Alternative Designs (may be taken concurrently); Prep. for students in joint programs with a department in another college is ED 3400 Analysis of the Instructional Process or equivalent.*

ED 3412, 3413 Seminar in the State of the Art and Field Project 8 Q.H.

Students will examine the current curricular and instructional issues in specific teaching areas or levels, hypothesizing and projecting possible future directions in curriculum and instruction in these areas; integration of the results of these inquiries into coherent understandings of the state of the art in these areas and the development of a special project to be implemented by the students within the context of their own teaching experiences. Seminars will be held over a period of two quarters every other week. *Prereq.: Teaching experience.*

ED 3414 Seminar in Supervision of Instruction/Reading

This seminar examines the role of the supervisor and consultant in organizing and implementing programs. Aspects include organizational plans, staff supervision and development, working with parents, and accommodating special needs children.

ED 3415 Seminar in Supervision of Instruction Practicum (8 Q.H.)

Students apply the skills learned in the seminar to a field setting. Student field work is supervised by

an on-site person and a professor. At periodic seminars, projects are selected and discussed. Students plan the projects and implement these in the field. Students also plan and carry out a project evaluation.

ED 3420 The English-Language Arts Curriculum

The design and function of the English-language arts curriculum; selected current issues as they impinge upon the English language arts curriculum; the design and function of research in the English language arts curriculum. Open to certified or experienced teachers. *Prereq.: Permission of instructor.*

ED 3421 Literature in the English-Language Arts Curriculum

The historical-social, psychological, personal, archetypal, textual, biographical, and philosophical-moral aspects of literary study and their relation to the chronological, thematic, and generic demands of the literature program; the sources of interest in literature as they related to the young reader and their implications for the English-language arts curriculum; the interrelatedness of literature and other components of the English-language arts curriculum. Each student will identify and investigate an area of individual interest. *Prereq.: ED 3420 The English-language arts curriculum or permission of instructor.*

ED 3422 Writing in the English-Language Arts Curriculum

The cognitive and effective bases of imaginative and nonimaginative writing; the role of writing in the relationship between self and object; modes of imaginative and nonimaginative writing appropriate to the young writer; the impulse to expression in the young writer and its implications for the English-language arts curriculum; the interrelatedness of writing and other components of the English-language arts curriculum. Each student will identify and investigate an area of individual interest. *Prereq.: ED 3420 The English-language arts curriculum or permission of instructor.*

ED 3423 Language in the English-Language Arts Curriculum

An examination of the multiple dimensions of language study in the English-language arts curriculum; the role of inquiry in the study of language and its implications for the English-language arts curriculum; theories of grammar and their relation to the study of language in the English-language arts curriculum; the interrelatedness of language and the other components of the English-language arts curriculum. Each student will identify and investigate an area of individual interest. *Prereq.: ED 3420 The English-Language Arts Curriculum or permission of instructor.*

ED 3424 Topics in English-Language Arts Education

An investigation of a matter of immediate concern to English-language arts education, but for which no organized study is ordinarily available. Typical topics include media in the English-language arts program, behavioral objectives in the English-language arts

program, the English-language arts program for the disadvantaged. Each year the seminar topic for that year is announced prior to registration.

ED 3425 English as a Second Language I

First course in teaching ESL, introducing the basic linguistic, cultural, and psychological concepts. Analysis of current approaches to teaching ESL locally and internationally from the standpoint of diagnosis, grouping, use of particular methods, and materials. Observations of local ongoing ESL programs will be included. *Prereq.: ED 3453 Diagnosis and Remediation of Reading and Language Disabilities I or permission of instructor.*

ED 3426 English as a Second Language II

Second course in the ESL sequence which emphasizes innovative means in teaching ESL. Specific projects according to student need and interest will be developed; supervised clinical work. *Prereq.: ED 3425 English as a Second Language I.*

ED 3427 Literature and Materials Seminar

Literature for children, adolescents, and adults; the sources of interest in literature as they relate to the reader; the interrelatedness of literature and other components of the language arts program; investigation of materials available. Students will develop projects related to their needs and interests.

ED 3430 History and the Social Studies in the School Curriculum

Permits the student to explore some of the fundamental concepts of anthropology, sociology, economics, political science, and history. Emphasis will be given to the interrelatedness of disciplines and to the extraction of operating principles from those that aid in the analyses of social problems. As a consequence of such analyses, the student should be equipped to find a greater variety of conceptual relationships with the historical social science field. From there a framework for evolving courses of study may be generated. *Prereq.: Teaching experience or certification.*

ED 3431 Social Science Materials Seminar

A curriculum course wherein the knowledge previously acquired will be used to establish criteria for the selection and development of curriculum materials. All materials of instruction will be viewed as means of implementation of objectives relating to specific social science concepts and skills. An effort will be made to personalize and concretize abstract phenomena and to demonstrate their impact on the quality of human lives. Students will examine and analyze prepared curricula and will be asked to develop original materials that include provision for the integration of a variety of thinking, reading, and social skills. *Prereq.: Teaching experience or certification.*

ED 3432 Seminar in Current Issues in the Social Studies

A content approach to problems of political, economic, and social significance which have contemporary relevance for teachers of the social sciences.

ED 3440 Remediation in Mathematics

An effective approach to the teaching of mathematics; diagnosis and remediation of difficulties, alternative teaching methods, techniques for the improvement of student skills and of student attitudes toward mathematics.

ED 3442 Seminar in Mathematics Education

Students are expected to analyze a mathematics learning problem, to investigate relevant research, and to prepare materials embodying their own proposed solutions. *Prereq.: Permission of instructor.*

ED 3444 Implementing Change in Science and Mathematics Education

The planning, organization, and execution of in-service experiences for teachers, related to all phases of science and mathematics education from subject matter courses to curriculum planning to materials workshops. *Prereq.: Teaching experience or certification.*

ED 3450 Foundations of Developmental Reading

Reading and writing as the receiving and generating of language; current developmental reading, writing, and related language skills; selected research findings bearing on relevant topics. (This course includes ten hours of observation or other field experience.)

ED 3451 Language and Reading

Introductory course in linguistics with emphasis on implications for reading and language instruction. Topics include the nature of language, introduction to the development of syntax, phonology and semantics, English orthography, the grammar of child language, and dialectology. *Prereq.: ED 0450 Foundations of Developmental Reading or consent of instructor.*

ED 3452 Current Issues in Reading and Language

Three or four topics of current interest in reading and language education are investigated in depth over a three- or four-week period each during the quarter. Typical topics might include lectures and reading on sexism in reading materials, Chapter 766 and its implications for reading and language education, "back to basics," reading and language in the open and alternative education program, problems of illiteracy, bilingual and bicultural education and reading/language instruction.

ED 3453 Diagnosis and Remediation of Reading and Language Disabilities I

Reading and language disabilities; causes and correlates of disability; language differences; aspects of measurement; diagnostic and corrective procedures in reading, writing, and related language skills; selected research findings bearing on relevant topics. *Prereq.: ED 3450 Foundations of Developmental Reading.*

ED 3454 Diagnosis and Remediation of Reading and Language Disabilities II

Second course in Reading and Language Disabilities, including an examination of selected models of language processes; cognitive and effective dimensions; problems in language pathology; and other

learning disabilities, including academic, perceptual-motor, and neurological areas. *Prereq.: ED 3453 Diagnosis and Remediation of Reading and Language Disabilities I and ED 3457 Clinical Practicum in Reading.*

ED 3455 Teaching Reading in Junior and Senior High School

Developmental or corrective reading programs at the secondary level. Development of reading rate, comprehension, interpretation, and study skills in the content areas.

ED 3456 Teaching Reading to the Deaf

Modern methods in use, such as the Fitzgerald Key and the Natural Language Approach. Emphasis is on using language in natural situations through lip reading and writing, with later emphasis on the formal presentation of language principles. Methods used to develop reading experiences that focus on content rather than mechanics are also covered as well as considerations appropriate to the development of a balanced reading program that provides adequate motivation, a wide variety of rich materials, a well-organized sequence of reading experiences, and provisions for evaluation.

ED 3457 Clinical Practicum in Reading

Practicum in clinical experience, tutoring children and adults with severe reading disabilities in the Reading Clinic for a total of seventy hours under close staff supervision. A one-hour seminar follows each tutoring session for purposes of discussion and case presentation. Diagnosis, lesson plans, daily logs, complete case history, and final progress evaluation are required of each student. *Prereq.: ED 3450 Foundations of Developmental Reading.*

ED 3458 Field Practicum in Reading

Eighty-hour field practicum offers students the opportunity to apply consulting and remediation skills in a school setting. Students may consult with teachers on the implementation of developmental and corrective reading and on reading in the content areas and also may provide diagnostic and remediation to pupils having special needs in reading. *Prereq.: ED 3453 Diagnosis and Remediation of Reading and Language Disabilities I and ED 3457 Clinical Practicum in Reading.*

ED 3461 Bilingual Education, Methods, and Materials

An introductory course in the problems, programs, and principles of bilingual/bicultural education. Emphasis will be on the current methods and materials used in programs nationally and internationally. Curricular aspects of bilingual/bicultural programs will be studied, as well as available research. *Prereq.: SOA 3135 Language and Communication, ENG 1118 Introduction to Linguistics, ENG 3404 Language and Its Structure, ED 3451 Language and Reading, or SLA 3650 Social Dialectology.*

ED 3462 Seminar: Ethnicity and Today's School Curriculum

Students will briefly review aspects of the history and culture of some ethnic groups to explore the unique manner in which certain universal needs are manifested. Prepared curricular materials, as well as authentic literary, visual, and artifact materials, will be analyzed, evaluated, and related to developed criteria, goals, and potential curricular impact in projecting the aforementioned cross-cultural needs or themes. Students will be asked to select, organize, and, as necessary, develop independent materials and strategies appropriate for classroom use. Efforts will be made to categorize developed units of work on various ethnic groups which appear to have significant parallel dimensions according to predetermined categories.

ED 3463 Urban Education: An Introduction to Teaching in City Schools

An introductory course offering students an overview of urban education, especially in the public schools. The demography of city schools is studied as a basis for identifying diverse special education needs of the multicultural population, such as ESL, bilingual education, and ESD. Study includes an overview and investigation of current curricular patterns related to this area of education. Readings, guest speakers, and first-hand observations of selected schools and programs are included in the course content.

ED 3470 Teaching Adults: Methods and Materials

Designed to help prepare participants to instruct adults in a variety of academic and nonacademic settings, the course emphasizes the skills and knowledge necessary to identify objectives, plan and execute appropriate lesson plans in keeping with students' requirements, develop curricula in a variety of settings, and evaluate students' performance. Class activities include the presentation of both theory and application through selected case studies that exemplify adult teaching in different environments. Participants also have the opportunity to acquire the necessary skills for developing individual models of adult teaching behavior to suit various circumstances.

ED 3471 Methods and Materials in Adult Literacy

This course will introduce students to some current diagnostic and instructional approaches to the functionally and totally illiterate adult. Current methods and materials will be analyzed and evaluated. Special projects may include the development of informal diagnostic instruments and/or instructional materials for particular adult learners. An overview of national and world literacy problems and programs will also be offered.

ED 3482 Principles of Programmed Instruction

The development and current status of self-instructional devices. A survey of available programs and teaching machines, including audiovisual machines, with emphasis on the details of the construction and evaluation of programs.

ED 3484 Selection and Utilization of Instructional Material

This course deals with all aspects of instructional media, surveying types, techniques, advantages, limitations, sources, and methods of using materials and equipment in specified areas. Emphasis is on the selection of appropriate media (print and non-print) to suit given learning objectives. Laboratory experience in operation of equipment and the production of instructional materials is provided.

ED 3486 Developing Multimedia Learning Packages

During this course each student will produce a multimedia (print and nonprint) instructional package for individualized learning.

ED 3800 Directed Study

This experience is provided for the student whose unique academic needs or interests cannot be adequately satisfied in any of the scheduled courses of the department. Not available to special students. *Prereq.: Approval of the chairperson of the department and of the director of the graduate school. (Approval forms must be submitted during the quarter prior to registration for the Directed Study.)*

ED 3801 Thesis

A research activity that may be elected by the student in lieu of two courses (8 quarter hours), with the approval and recommendation of the adviser.

ED 3821 Workshop in Elementary Education

(See general workshop description on page 86.)

ED 3822 Workshop in Secondary Education

(See general workshop description on page 86.)

ED 3825 Institute in Elementary Education

(See general institute description on page 86.)

ED 3826 Institute in Secondary Education

(See general institute description on page 86.)

Educational Administration

ED 3500 Leadership in Education, Part I

Part I of a two-term core course designed to introduce the student to concepts of formal organization. This core, consisting of a two-part sequence, is prerequisite to further study in the Department of Educational Administration. Part I may provide the student with an overview of formal organizations as social systems, with emphasis given to the leadership function. Relationships between individuals and organizations are considered. Communications and decision-making functions are analyzed and examined.

ED 3501 Leadership in Education, Part II

Part II continues an emphasis on the leadership function in organizations. It examines selected informal organization elements such as motivation, normative order, social power, conflict, conformity, and creativity. Attention is given to processes of change and innovation in organizations. *Prereq.: ED 3500 must be completed before enrollment in ED 3501.*

ED 3502 Instructional Leadership: Curriculum Development and Supervision

This course views the responsibilities of administrative personnel relating to the improvement of curricular and instructional practices. Evaluative techniques, inservice education, supervisory procedures, and innovative programs are among the areas of consideration. Students may have the opportunity to become engaged in supervisory projects individually or in small teams. *Prereq.: ED 3500 and ED 3501, or permission of instructor.*

Certain of the following courses in Educational Administration may be open only to CAGS and doctoral degree candidates or by special permission of the department chairperson, granted prior to registration.

ED 3503 Current Issues in Educational Administration

A seminar required of all students pursuing the CAGS. Critical and contemporary issues which face administrators will be examined. The status of the administrator; federal, state, and local revenue sources; accountability; teacher militancy; equal educational opportunity; controls of schools; and urban education problems are examples of topics that will be analyzed.

ED 3504 Human Relations Skills for Administrators

This course offers students the opportunity to examine methods of diagnosing problems and responding in management contexts; analyzing the norms, influence patterns, roles, and control systems of organizations; performing some of the critical skills required in the leadership of human organizations; and managing an intervention for the purpose of solving an organizational problem. *Prereq.: CRS 3405 Group Dynamics or equivalent.*

ED 3505 The Process of Administration

A course required of all students pursuing the CAGS. Case analysis and group activity will be utilized to gain insight into such areas as the improvement of organizational morale, professional job satisfaction, and current issues of involvement and conflict. Students will also examine alternative courses of action to cope with problematical events confronting educational administrators.

ED 3506 Administration of Early Childhood Education

This course will include the study of significant elements of administration unique to the planning, implementation, and operation of an early childhood education center. Areas of concern are funding sources, intra-institutional relationships, patterns for

designing early childhood programs, onsite visitations, modes of private governance, use of plant, student and teacher placement, role of volunteers, and related topics. *Prereq.: ED 3500 and ED 3501.*

ED 3507 Administration of the Elementary School

A survey of the operational tasks performed by the elementary school administrator. Included will be school-community relations, student personnel, staff personnel, curriculum and instruction, physical facilities, finance and business management, and organizational structure. *Prereq.: ED 3500, ED 3501, or permission of instructor.*

ED 3508 Administration of the Secondary School

A survey of the operational tasks performed by the secondary school administrator. Included will be school-community relations, student personnel, staff personnel, curriculum and instruction, physical facilities, finance and business management, and organizational structure. *Prereq.: ED 3500, ED 3501, or permission of instructor.*

ED 3509 Administration of Two-Year Colleges

Emergence of the community college movement in the United States, administrative structures and governance, the role of faculty in planning, the student population and related student personnel services will be examined. Particular emphasis is placed upon the identification and utilization of community resources in curriculum development and the college's total relationships with the community in which it exists. The two-year technical institute and both publicly and privately supported junior colleges will be studied. Field visits are an integral part of course requirements.

ED 3510 Academic Administration in Higher Education

Recruitment of properly qualified faculty and staff is only one problem of the academic administrator. This course will also consider the problems of pupil services, admissions, athletics, curriculum development, accreditation, instructional resources, registration and scheduling, faculty organization, continuing education, faculty rights and responsibilities, and personnel policies.

ED 3511 Administration of Cooperative Education

An examination of significant elements in the planning, implementation, and operation of a cooperative education program. Areas of concern include agents for institutional change, intrainstitutional relationships, program costs and funding sources, cooperative education calendars, development of cooperative work assignments, relationships with cooperative employers, and operational policies.

ED 3512 Administration of Adult and Continuing Education

The historical development of adult and part-time education, with attention to the present status and trends for the future, will be studied, with emphasis on the administration of these programs. A variety of adult educational programs in schools, colleges, junior colleges, religious agencies, social service organizations, business and industry, and professional

organizations will be included, focusing on planning, implementing, administering, financing, and evaluating such programs.

ED 3513 Problems in Urban School Administration

This course examines the problems of educational administration in the complex city school system with emphasis on solutions to educational problems caused by the unique demographic characteristics of the city.

ED 3514 Administration of Experiential Education Programs

This course will focus on the planning, organizing, budgeting, implementing, and evaluating of experiential education programs, with particular emphasis on work-related programs in a variety of countries. An examination of the development and operation of such programs as cooperative education, cooperative work experience, external degree, "sandwich courses," "*enseignement en alternance*," study service, and other work/school arrangements will lead to discussion of the administrative problems involved. Additional topics may include off-campus learning, administrative involvement in assessment, appropriate supervision techniques, and the development of a rationale for work in the curriculum.

ED 3515 The Administrator's Role in Supervision and Evaluation

The course examines the leadership role as it relates to supervision and evaluation. Through role playing, case analysis, and the use of videotapes, students have the opportunity to engage in activities typically required of building or unit administrators. A variety of supervisory and evaluation techniques and formats appropriate to both formative and summative evaluations are presented for examination.

ED 3516 Administration and Supervision of Special Education

Designed for advanced graduate students preparing for administrative or supervisory positions in special education programs. Facilities and curriculum adjustments, staff roles, methods and content for inservice training, and the use of the team approach are studied. Field trips to observe and evaluate programs may be required.

ED 3517 Simulated Problems: Elementary School Administration

The course is designed to place each student in a simulated decision-making situation as a principal or administrator of an elementary school. Background materials have been prepared which describe all aspects of a school system, including its publics, its policies, its certified and noncertified staff members, and its geographical and socioeconomic makeup. These background data may be disseminated through motion pictures, film strips, and taped interviews with influential people in the community, as well as through written materials. *Prereq.: ED 3500, ED 3501, or permission of instructor.*

ED 3518 Simulated Problems: Secondary School Administration

The course is designed to place each student in a simulated decision-making situation as a principal or administrator of a secondary school. Background materials have been prepared which describe all aspects of a school system, including its publics, its policies, its certified and noncertified staff members, and its geographical and socioeconomic makeup. These background data may be disseminated through motion pictures, film strips, and taped interviews with influential people in the community, as well as through written materials. *Prereq.: ED 3500, ED 3501, or permission of instructor.*

ED 3521 Problems in College Administration: A Simulated Experience

This seminar is designed to place each student in simulated decision-making situations as an administrator of a college or junior college. Background materials have been prepared which describe many aspects of a college, including its policies, the makeup of its faculty and student body, its financial situation, the community it serves, and its board of control. *Prereq.: ED 3528 Financial Management in Higher Education or permission of instructor.*

ED 3522 Simulated Problems: Administration of Occupational and Career Education

Each student is confronted with a series of simulated decision-making situations such as those which are usually faced by administrators of programs in the area of occupational and career education. Readings, audiovisual material, and class interactions constitute the design of this course.

ED 3523 Seminar in Educational Administration

A culminating experience for students majoring in school administration at the master's level. The student is confronted with major issues facing the school and its administrators. Emphasis is placed upon applying knowledge gained in previous administrative courses to an understanding of contemporary education problems. *Prereq.: ED 3500, ED 3501, or permission of instructor.*

ED 3524 Seminar in Occupational and Career Education

Students will be confronted with a sampling of the major issues facing administrators and supervisors of occupational and career education programs in their efforts to organize, promote, and operate such programs. Emphasis will be placed on applying the knowledge acquired in previous courses and other program experiences to arrive at an understanding of contemporary occupational and career education problems and their solutions.

ED 3525 Personnel Administration

The purposes, patterns, and issues in personnel administration are the major considerations of the course. Study will include the skills, attitudes, and knowledge which an institutional staff needs to have and which are essential to the accomplishments of organizational goals. Personnel administration pro-

grams and problems will serve as the focus for the course.

ED 3526 Educational Finance

The study of school finance deals with the principles and problems of financing education, and also considers the basic concepts of economics relative to the place of school finance in the field of public finance. The sources and rationale for public support of schools are examined. Selected state and federal aid programs, capital outlay programs, current practices and issues of local support, and bond issue campaigns are included in this study.

ED 3527 School Business Management

Practices and issues in the administration of school business affairs are the major concerns of the course. The role of the school business administrator and the educational budget will be examined. Attention will be paid to principles of budget preparation and development, purchasing, supply management and distribution, school accounting and data-processing systems, auditing, financial reporting and management of payroll, transportation programs, and school food services, and the operation and maintenance programs for the physical plants. In addition, each student will be placed in a simulated decision-making situation. Background materials have been prepared describing aspects of a fictitious school system, including its publics, policies, and other relevant information. Each student may have the opportunity to deal with matters typically faced by the school business administrator.

ED 3528 Financial Management in Higher Education

This course seeks to combine a knowledge of fund-raising activities with the study of proper financial management in higher educational institutions. The problems of fund raising for both public and private, two- and four-year institutions will be considered. Modern techniques of budget preparation and control may include purchasing, school accounting, data processing, providing benefits for faculty, financial reporting, food services, housing, and operation and maintenance of the physical plant.

ED 3529 School Plant Planning, Operation, and Maintenance

This course seeks to have the student develop a basic understanding of the processes involved in the planning, maintenance, and operation of school plants. Such items as educational specifications, the process of school construction, techniques for providing clean, safe, and healthy environments for the teaching-learning process, along with the selection, assignment, and supervision of custodial and maintenance staff will be involved. Statutes or regulations pertaining to these processes used by state and local regulatory bodies will also be reviewed. Consideration will be given to issues related to declining enrollments and school closings.

ED 3530 Institutional Planning and Facilities

This course will consider the planning of new colleges as well as the expansion and maintenance of existing ones. Systems analysis, needs surveys, and

development of educational specifications for college facilities will constitute half of the course. The other half will involve studying the operation and maintenance of the physical plant, including provisions for housing, safety, parking, communications, and health service.

ED 3531 Systems Theory in Education

This course is required of all students pursuing the CAGS. The course provides the student with an introduction to general systems concepts and terminology as well as the implications of systems theory to leadership and administration. Topics include systems applications such as input/output analysis, PERT, feedback monitoring and response, flowchart logic, and the computer as a system. Consideration is given to systems study as a method of planning and evaluation.

ED 3532 Organizational Analysis

Open only to advanced graduate students, this course will include examination of different approaches used to define traits or characteristics of formal organization. Special emphasis will be placed on the application of models, typologies, and schemes to identify structural or procedural deficiencies in bureaucratic social systems. *Prereq.: Permission of instructor.*

ED 3534 School-Community Relations

This course includes the study and design of school-community relations programs based on the principles and practices of the intercommunications between the school and its several publics. Selected research findings relative to public relations programs in business, industry, and governmental agencies will be reviewed in addition to those involving educational systems. Stress will be placed on the role of the administrator in the development of a comprehensive program of school community relations to the administrative unit.

ED 3535 School Law

The student will be expected to develop a basic understanding of federal and state laws that apply to school systems, educational programs, and personnel, as well as of the legal prerogatives available to the practicing administrator and the local boards of education. This study will include consideration of the constitutional, statutory, and common-law foundations of educational systems and the school administrator's role with respect to them.

ED 3536 Collective Negotiations in Education

This course is designed to provide prospective administrators and those already engaged in administration with knowledge of the collective negotiation process and collective negotiation strategies and tactics. Designed as a systems approach to collective negotiations, simulation exercises and cases will be used to provide practical exercises for students. When arrangements can be made, guest lecturers experienced in collective negotiations will be invited to the seminar.

E 3537 Program Planning and Workshop Design

Administrators who wish to be effective must know the techniques for directing client-needs assess-

ment. This course presents a variety of strategies designed to help students develop skill at assessing client needs, followed by discussions regarding ways in which these needs are translated into program/workshop objectives. The administrator's role in program and workshop design, with emphasis on managing the learning activities, is demonstrated through student involvement in administrative activities. Attention is devoted to the variety of settings in which adult-education administrators work, including educational institutions, business and industry, governmental agencies, and human-service organizations.

ED 3538 Securing and Administering Grants in Education

This course is designed to provide school administrators with knowledge of fund raising for educational purposes and supervisory techniques for funded programs. Designed as a systems approach to grantsmanship, the course will emphasize the methods and techniques of fund raising, program planning, and proposal writing.

ED 3540 Typologies of Higher Education

A study of the types of higher educational institutions, with emphasis on organizational structure, modes of governance, and administration. The history of higher education, particularly the development of colleges, universities, and junior colleges in the United States, will be considered to provide perspective for the modern college administrator. Important issues and the problems they present for administrators will provide the major focus of this course.

ED 3541 Innovation and Change

A course required of all students pursuing the CAGS. Major emphasis is upon administrative strategies in effecting structural alterations, curricular organization, and instructional techniques. The nature of these alterations varies with the particular problems relevant to the issues that receive consideration.

ED 3542 Politics and Educational Decision Making

This course examines federal, state, and local governmental arrangements and political processes which influence educational policies of school systems. Emphasis is given to the application of political science concepts and research methods to educational policy-making processes and to the political environment surrounding the educational administrator.

ED 3543 Directed Field Experiences in the Administration of the Elementary School

Required of all master's candidates who major in school administration. Study and discussion of administrative functions may be coordinated with selected field trips to administrative settings and with guest lectures by practicing elementary school administrators. These experiences usually involve visits to such settings as an elementary school, a middle school, a superintendent's office, a school committee meeting, and appropriate federal and state agencies. In addition, each student will be expected to partic-

ipate in an administrative field experience in an elementary setting for a minimum of four hours per week. *Prereq.: ED 3500 or permission of instructor.*

ED 3544 Directed Field Experiences in the Administration of the Secondary School

A companion course to ED 3543, required of all master's candidates in school administration. Study and discussion of administrative functions may be coordinated with selected field trips to administrative settings and with guest lectures by practicing secondary school administrators. These experiences are aimed at educational agencies at the secondary level and may include visits to a comprehensive high school, a junior high school, a regional vocational-technical school, a superintendent's office, a school committee meeting, and appropriate federal and state agencies. In addition, each student will be required to participate in an administrative field experience in a secondary school for a minimum of four hours each week. *Prereq.: ED 3500 or permission of instructor.* (ED 3544 may be a continuation of ED 3543 or may precede it.)

ED 3545 Administrative Internship

This is an individualized offering involving supervised observations, internships, externships, and seminars in educational administration. It is designed to provide further practical experience in the student's area of administrative preparation. The administrative internship program must be worked out with the adviser not later than the end of the second week of the quarter preceding the quarter during which the internship will take place.

ED 3546 Special Education Administrative Internship

An individualized offering for students preparing for administrative roles in areas of special education. The course offers experiences in supervised observations, internships, externships, and seminars in special education administration. The administrative internship program must be worked out with the student's adviser not later than the end of the second week of the quarter preceding that in which the internship is to take place.

ED 3800 Directed Study

This experience is provided for the student whose unique academic needs or interests cannot be adequately satisfied in any of the scheduled courses of the department. *Not available to special students.* *Prereq.: Approval of the chairperson of the department and of the director of the graduate school. (Approval forms must be submitted during the quarter prior to registration for the Directed Study.)*

ED 3801 Thesis

A research activity that may be selected by the student in lieu of two courses (8 quarter hours), with the approval and recommendation of the adviser.

ED 3806, 3807, 3808 Doctoral Seminar in Leadership; Administration and Supervision I, II, III

A series of three seminars required of all students pursuing the Ed.D. degree. The dialogues in these courses will use an interdisciplinary approach to explore complex behavioral and structural interactions found in formal organizations. Major emphasis will be placed upon integrating theoretical concerns with practical administrative functioning.

This sequence of seminars is viewed primarily as a pooling of the results of extensive individual student research and activities and is aimed at giving the student an overview of all aspects of the institution he or she will be leading. (These seminars open only to students who have been accepted to a doctoral program.)

ED 3809 Doctoral Dissertation

Prereq.: Admission to candidacy in the Doctor of Education degree program.

ED 3823 Workshop in Administration

(See general workshop description on page 86.)

ED 3827 Institute in Educational Administration

(See general institute description on page 86.)

Health, Sport, and Leisure Studies

HSL 3500 Health Issues: Implications for Education

An analysis of selected major health issues in health education. Emphasis is on the importance of current research findings to health education programs in a variety of settings.

HSL 3501 School Health Education Curriculum

A study of selected curricula for school health programs, emphasizing the organization of curriculum components into an effective approach to health promotion and disease prevention in the school setting. An attempt is made to relate course activities to the needs of Massachusetts schools.

HSL 3502 Educational Strategies in Health Education

An analysis of contemporary educational techniques, concepts, and approaches of importance to the health educator in a school, community health agency, or medical setting. The use of educational diagnosis in determining appropriate educational strategies is emphasized as the major means of preventing health problems and improving health status. Health behavior models are presented as a basis for educational diagnosis.

HSL 3503 Contemporary World Health

A survey of the state of the world's health, the progress which has been made in improving global health status, and the difficulties yet to be overcome. The importance of "partners in health," as opposed to the solitary research worker, in reaching the current health needs is emphasized. Study includes an examination of the contributions of WHO, UNESCO, UNICEF, and FAO.

HSL 3504 Environmental Health

A review of the regional, national, and international status of the environment and its impact upon individual and community health. Major focus is on de-

veloping an understanding of the etiology of environmental problems such as overpopulation, pollution of air and water, radiation exposure, noise, and waste disposal.

HSL 3505 Consumer Health

Analysis and evaluation of the concepts involved in the careful selection of health products and services. Areas for student exploration and study projects include decision making relative to the selection of health products and services, evaluating advertising, quackery, and protection against useless or dangerous products through consumer organizations.

HSL 3506 Nutrition

A study of dietary nutrients and their influence on the health status of individuals at various stages of the life cycle. *Prereq.: Anatomy and Physiology or permission of instructor.*

HSL 3600 Administration of Physical Education and Athletics

Physical education and athletics discussed as an entity consistent with the current emphasis on unity, economy, and equal opportunity. Modern practices and principles of general administration applied to problems of staffing, scheduling, budgeting, collective bargaining, personnel welfare, program development, and public relations. All levels of education and the broad spectrum of programs common to physical education and athletics are considered.

HSL 3605 Problems in Contemporary Athletics for Men and Women

Current problems, practices, and national issues pertinent to the conduct of athletic competition. National, state, and conference organizations are studied.

HSL 3606 Applied Evaluation in Curriculum and Instruction

Application of current educational evaluation theory to concepts of instruction and curriculum development in physical education. Includes formative and summative measures applied to the improvement of instruction, assessment of process and product in the educational program, interaction analysis. *Prereq.: HSL 3501 or HSL 3644.*

HSL 3608 Advances in Instructional Concepts

Current practices in, and a search for new approaches to instruction in physical education. Includes analysis of teaching and learning styles, available instructional technology, and the implementation of instructional designs in physical education classes.

HSL 3609 Physical Education for Students with Special Needs

Study of the movement problems and characteristics of special-needs populations. Assessment, planning, instruction, and evaluation practices recommended for work with special-needs students in physical education classes. *Prereq.: Adapted Physical Education or permission of instructor.*

HSL 3610 Management of Adapted Movement Performance Programs

Analysis of legal, behavioral, and environmental concepts related to specialized physical education/motor development programs and investigation of national management systems. *Prereq.: HSL 3609 or HSL 3442 or equivalent graduate course.*

HSL 3615 Anatomic Kinesiology

A study of the human musculoskeletal system and its relationship to human movement patterns. Electromyography is used in assessing muscle-movement relationships. Current electromyographic research and techniques are investigated. *Prereq.: Kinesiology or permission of instructor.*

HSL 3616 Mechanical Analysis of Sport

Application of mechanics of motion to the analysis of human motion. Emphasis is placed on cinematography and film analysis procedures in teaching and research. *Prereq.: HSL 3615 Anatomic Kinesiology or permission of instructor.*

HSL 3617 Physical Fitness Appraisal and Guidance

Physical fitness screening tests and procedures, developmental programs, fitness-producing activities, and current trends in testing and research. *Prereq.: Exercise Physiology and Measurement and Evaluation or permission of instructor.*

HSL 3618 Exercise in Cardiovascular Health and Disease

Acute and chronic effects of exercise upon the cardiovascular, respiratory, metabolic, and muscular systems. Principles of human performance assessment and exercise prescription applied to adults in exercise-based prevention, intervention, and post-coronary programs. *Prereq.: Exercise Physiology or Advanced Physiology.*

HSL 3619 Electrocardiography

A study of basic and intermediate electrocardiography, including cardiac function, lead systems, rate, rhythm, axis, infarction, ischemia, hypertrophy, effects of cardiovascular drugs, and purposes and principles of exercise testing. *Prereq.: HSL 3618.*

HSL 3620 Laboratory in Exercise Testing and Prescription

Practicum in graded exercise testing, including determination of EKG, blood pressure, pulmonary, and metabolic response to exercise; pulmonary function testing; assessment of body composition; and tests of muscular strength, endurance, and flexibility; prescription of exercise for persons in cardiopulmonary prevention, intervention, and rehabilitation programs. Students are expected to do fieldwork as exercise technicians and leaders in prevention and/or rehabilitation programs. As part of the course requirements, each student must conduct a laboratory project. *Prereq.: HSL 3618 and HSL 3607 (HSL 3607 may be taken concurrently).*

HSL 3621 Advanced Cardiovascular Physiology

A review of the current knowledge of cardiovascular function relating the physiology of the circulatory system in its normal, diseased, and stressed states. The interaction between the components of the system will be emphasized. Current research topics will be covered. *Prereq.: HSL 3618 Exercise in Cardiovascular Health and Disease.*

HSL 3622 Cardiovascular Pharmacodynamics in Exercise Physiology

A study of the current medications used in the treatment of congestive heart failure, coronary artery disease, arrhythmias, angina, and hypertension; the effects of these medications during acute and chronic exercise; and cardiac emergency medications. *Prereq.: HSL 3619 Electrocardiography and PTH 3500 Cardiopulmonary Pathophysiology.*

HSL 3625 Trauma Assessment and Treatment in Sport

An investigation of injury pathology, evaluative testing, diagnosis, and appropriate treatment modalities. *Prereq.: Undergraduate Athletic Training or experience.*

HSL 3626 Reconditioning in Sports Injury

Rehabilitation procedures and techniques appropriate to the post-injury retraining of athletes. *Prereq.: Adapted Physical Education or permission of instructor.*

HSL 3630 Perceptual-Motor Development

A survey of the development of movement control from birth to maturity. Changes in motor performance due to age, motor development expected at various stages, and the interrelations of such factors as growth, social context, cultural expectation, motor abilities, and sequential changes in motor control are examined.

HSL 3631 Movement and the Learning Process

An examination of the scientific method as applied to the learning and performance of motor skills. The course surveys a range of theoretical positions and

includes laboratory experiences as well as the interpretation of motor-learning studies. Major variables affecting motor learning and performance are examined from several theoretical standpoints. *Prereq.: HSL 3630 Perceptual-Motor Development or permission of instructor.*

HSL 3632 Early Childhood Motor Patterns

An examination of observational and experimental aspects of developmental motor learning. The sequential development of motor skills and various factors contributing to motor control development, as well as current issues in movement development, are studied. *Prereq.: HSL 3631 Movement and the Learning Process or permission of instructor.*

HSL 3640 Comparative Physical Education

Both past and present philosophies and practices of national and international programs in physical education are compared. Historical analysis is introduced as a research technique.

HSL 3641 Philosophies in Physical Education and Sport

An exploration of major philosophies, past and present, and their influence on modern physical education and sport. Students are expected to delineate their personal philosophies, explore philosophical analysis as a research technique, and review philosophical research. *Prereq.: Philosophy, Philosophy of Education, or permission of instructor.*

HSL 3642 Sociology of Sport

An analysis of the sociological principles and factors operative in the interaction between sport and society. Pertinent literature and research are reviewed. Topics of discussion include the pervasiveness of sport, social stratification, politics, economics, sport and the mass media, race, women, violence, competition, deviance, subcultures, and sport in the future. *Prereq.: General Psychology or permission of instructor.*

HSL 3643 Psychology of Coaching and Sport

The psychodynamics of the athlete and the coach, with particular reference to personality, maturation, motivation, learning, emotions, and perception. Individualized projects are required. *Prereq.: General Psychology or permission of instructor.*

HSL 3650 Planning and Developing Facilities for Physical Education and Recreation

The principles, terminology, and standards for planning, constructing, and using indoor and outdoor facilities for physical education and recreation. Integrated planning among all municipal departments is stressed.

HSL 3651 Supervision of Professional Personnel

Study of ways of effectively matching the needs of individuals with those of the organization. Emphasis on leadership, conflict resolution, and evaluation from an organizational development perspective.

HSL 3652 Critical Thinking and Evaluation in Physical Education and Recreation and Leisure Studies

Investigation of the acquisition of knowledge in two disciplines. Examination includes evaluating knowledge and practice through experiences in decision making, logical analysis, and critical thinking.

HSL 3653 Legal Issues in Recreation (3 Q.H.) and Sport

Analysis of recreation and sport from legal, social, and economic standpoints. Emphasis on the impact of law and legal principles on recreation and sport.

HSL 3655 Facilities and Operations (3 Q.H.) Management

Study of the day-to-day work required of operating managers in selected leisure industry settings. Particular emphasis is placed on how computer technology and human relations can best be used to carry out the operations of an organization.

HSL 3894 Independent Study

Under the guidance and direction of a program adviser, students have the opportunity to develop and conduct projects related to their professional interests. *Prereq.: written proposal and permission of program adviser.*

HSL 3898, 3899 Seminar/Workshop

Special seminars or workshops in physical education on topics of timely interest. Graduate credit may be granted for successful completion of a workshop, but credit may not be applied toward a degree program without the program adviser's approval. A maximum of eight quarter hours earned in seminars or workshops may be applied toward the degree.

HSL 3822, 3823 Seminar/Workshop

Special seminars or workshops in recreation and leisure studies on topics of timely interest. Graduate credit may be granted for successful completion of a workshop, but credit may not be applied toward a degree program without the program adviser's approval. A maximum of eight quarter hours earned in seminars or workshops may be applied toward the degree.

HSL 3410 Contemporary Theories of Recreation and Sport

Historical and philosophical perspectives of recreation, sport, and leisure. Special emphasis on change over time and its implications for the leisure industry.

HSL 3411 Program Evaluation in Recreation and Leisure Services

Focuses on comprehensive systems for evaluating program effectiveness as they relate to the consumer of recreation and leisure services. Major emphasis is placed on developing an evaluation system for an agency of the student's choice. Case studies are drawn from the public, nonprofit, and commercial sectors. *Required of all students in Recreation and Leisure Studies.*

HSL 3412 Seminar in Contemporary Issues and Problems in Recreation and Leisure Services

Discussion of national and international issues, current trends, and contemporary problems as they affect recreation services. *Required of all students in Recreation and Leisure Studies. Prereq.: HSL 3410.*

HSL 3420 Grantsmanship

A seminar in which the student has the opportunity to develop a grant proposal for submission to a funding source chosen by the student. Government and foundation grant programs are explored.

HSL 3421 Budget Analysis

Capital and operating budgets are analyzed using such techniques as cost-effectiveness and benefit-cost analysis, forecasting, and present value analysis. The concepts of depreciation, direct and indirect costs, and service volume are studied as they relate to pricing decisions. Focus is on improving management decisions.

HSL 3422 Administration of Resident Camp Programs

An in-depth study of staffing, sanitation, and health; purchasing and storage of food, materials, equipment, and supplies; kitchen management; insurance, construction, and maintenance of buildings; and program areas as they affect resident camping programs. A study of nationwide goals and trends in the camping movement is included.

HSL 3423 Advanced Organization and

Administration of Recreation and Leisure Services
Patterns for the implementation of recreation and leisure services by school systems, voluntary agencies, national service organizations, municipal governments, and state and federal agencies investigated in depth.

HSL 3424 Programs in Recreation and Leisure Services

An examination and evaluation of program content, leadership, administration, and facilities in recreation and leisure services sponsored under public, private, religious, industrial, and voluntary auspices.

HSL 3425 Public Relations for Recreation and Leisure Service Agencies

The central purpose of public relations is to influence public opinion. This course focuses on practical and ethical aspects of public relations for recreation and leisure service agencies. Case studies are drawn from the public, nonprofit, and commercial sectors.

HSL 3426 Politics and Bureaucracy in Recreation and Leisure Services

Practical problems faced by recreation professionals in public service are investigated. Students study relationships between elected officials, bureaucrats, peers, subordinates, and supervisors in state and local governments.

HSL 3427 Recreation and the Community School: Concepts and Practices

The role of recreation studies as an integral part of programming for the community school. An analysis of the community school concept with regard to philosophy, physical plant requirements, personnel, finance, and community involvement.

HSL 3428 Leisure and Delinquent Behavior

Recreation studied as an intervention strategy to prevent and rehabilitate delinquent behavior.

HSL 3441 Seminar on Programming in Therapeutic Recreation

An overview of systems analysis and design techniques and their application. Emphasis is on therapeutic recreation planning at the administrative level. *Prereq.: An undergraduate program planning course in therapeutic recreation.*

HSL 3442 Therapeutic Recreation Services for Individuals with Disabilities

An introduction to the nature and scope of therapeutic recreation, including a review of its history and recent advances in professionalization. The role of service delivery in various settings and the major issues confronting this professional specialization are examined.

HSL 3443 Observations of Therapeutic Recreation in Treatment Settings

Guided observation sessions under professional supervision in various clinical settings. Group seminars are held to familiarize students as to the role of the rehabilitation team. *Prereq.: HSL 3442 or permission of the instructor.*

HSL 3450 European Mountaineering

An intense six-day course that covers the basic skills of technical climbing. The course is conducted by the International School of Mountaineering. English-speaking guides extend all students to the utmost of their abilities in various climbing situations: free climbing; ice climbing near Chamonix, France; artificial climbing; or mountain rescue. Climbing is done in a voluntary, relaxed manner with the purpose of learning to enjoy the mountains creatively and safely.

HSL 3451 European Backpacking and Orienteering

A practical course in the basics of safe mountain living and travel on foot. Subjects covered include group leadership, fauna and flora of the Alpine environment, mountain geology, mountain first aid, and orienteering. Students have the opportunity to participate in several day hikes in the vicinity of Leysin, where scenic walking paths abound, and two extended back-packing trips in contrasting areas of Switzerland. The European style of back-packing differs greatly from the traditional American practice of tenting, employing Alpine huts and refuges.

HSL 3452 Comparative European Recreation

A presentation of recreation, European-style. Guest lecturers, movies, group discussion, and field trips

help to present the Western European approach to recreation and sport. The critical contemporary issues of facility construction, program structure and development, government support, and treatment of special populations are viewed through the European perspective and compared to the American scene. Among the topics included are recreation and tourism in a mountain society, the European club system, Swiss park construction, therapeutic recreation in Switzerland, mountain rescue, and tourism as a part of recreation. The outstanding recreation facilities of Geneva are visited during the course. A written test and paper are required.

Physical Therapy

PTH 3510 Cardiac Rehabilitation (2 Q.H.) **Programs Phases I and II**

Survey of various cardiac rehabilitation programs, their objectives, relevant medical considerations, indications, and contraindications. Topics for examination include referrals, organizational structure, proposal writing, liabilities, and insurance plans available for these two phases of rehabilitation. *Prereq.: PTH 3560 or permission of instructor.*

PTH 3515 Pulmonary Rehabilitation (2 Q.H.) **Programs**

Theory and practice of pulmonary therapy. Analysis of treatment procedures utilized with medical and surgical respiratory patients. *Prereq.: PTH 3560 or permission of instructor.*

PTH 3500 Cardiopulmonary Pathophysiology

Lecture and laboratory study of anatomy, physiology, and pathophysiology for the cardiac and pulmonary systems as applied to the dysfunction and rehabilitation of the cardiopulmonary patient. *Prereq.: HSL 3618.*

PTH 3505 Cardiopulmonary Diagnostic Techniques

An overview of the various noninvasive and invasive techniques for diagnostic purposes, including examination of these techniques as guidelines useful in determining the extent of cardiopulmonary damage, work capacity, and residual function. Techniques studied include electrocardiography, systolic time intervals, pulmonary function, laboratory test findings, and gas analysis. *Prereq.: PTH 3560, HSL 3618, or permission of instructor.*

PTH 3527 Medical and Surgical Conditions of Cardiac and Pulmonary Patients

This course is designed to examine current medical and surgical treatment of cardiac and pulmonary anomalies and dysfunction. The acute and chronic disorders which cause these dysfunctions, as well as their etiologies, symptomatology, and treatment will be investigated. The techniques of various surgical procedures will be identified as well as the preoperative, intraoperative, and postoperative management of the patient. The role of the physical therapist will also be extensively investigated. *Prereq.:*

HSL 3820 Practicum in Clinical Recreation

A minimum of seventy-five clock hours of supervised professional experience, required of those students who do not have a degree in Recreation and Leisure Studies or sufficient professional work experience. Students are assigned as interns to agencies or institutions that offer services in the area of therapeutic recreation and rehabilitation, community and municipal recreation, or commercial recreation. Credit not applicable toward degree.

Minimum of one year in cardiopulmonary therapy, PTH 3560 Practicum in Physical Therapy I, or permission of instructor.

PTH 3530 Basic Applied Neuroanatomy

Study of the human nervous system from a functional perspective, including analysis of components of the nervous system as they related to common clinical problems. Emphasis is placed upon the therapist's role in recognizing and treating these problems. *Prereq.: Gross Human Anatomy or permission of instructor.*

PTH 3535 Advanced Functional Neuroanatomy

Anatomy of the nervous system is studied from a functional perspective. The course focuses on the role of the cortex, basal ganglia, thalamus, and cerebellum in regulation of tone control, sensation, and posture. Current and classic literature will be used. *Prereq.: PTH 3530 Basic Applied Neuroanatomy.*

PTH 3540 Advanced Topics in Neurodevelopment

Examination and interpretation of both classic and current nonhuman and human research studies. Seminar format. *Prereq.: One year of clinical experience in neurology or PTH 3560 Practicum in Physical Therapy I or permission of instructor.*

PTH 3545 Neuromuscular Physiology

Classic concepts of normal muscle and nerve structure and function. Clinical impacts of disease and injury on neuromuscular morphology and physiology are emphasized where appropriate. The course also gives the student the opportunity to become familiar with current theory that may be relevant to evaluation and management courses offered in the program.

PTH 3550 Evaluation of the Neurologically Impaired Adult

The course provides a framework for analyzing motor dysfunction, based on the fundamental properties underlying movement disorders. This framework is then used to critique current evaluations of neurologic disabilities and to develop a rationale for a logical and comprehensive evaluation of the neurologically impaired adult. *Prereq.: PTH 3560 Practicum in Physical Therapy I or equivalent or permission of instructor.*

PTH 3555 Treatment of the Neurologically Impaired Adult

Treatment of the neurologically impaired adult is discussed from a historical perspective and from current neurological and neurophysiologic knowledge. Current techniques are critiqued from a clinical and theoretical point of view. Topics include specific treatment techniques as well as specific neurologic disabilities. *Prereq.: One year clinical experience in physical therapy with background in treatment of neurologic patient and PTH 3550.*

PTH 3560 Practicum in Physical Therapy I

Practicum in supervised clinical practice within the specified specialty area. Students are expected to complete 240 hours of clinical experience in a health-care setting. *Required as a prerequisite in selected courses for those students who do not have a minimum of one year of clinical experience at the time of registration for these courses.*

PTH 3570 Evaluation of the Neurologically Impaired Infant and Child

Clinical test and measurement background information applied to advanced assessment and treatment approach for the pediatric neurological patient classically seen by the clinical specialist in neurological physical therapy. *Prereq.: PTH 3540 Advanced Topics in Neurodevelopment.*

PTH 3575 Treatment of the Neurologically Impaired Infant and Child

Advanced treatments for the pediatric patient with neurological disorders are discussed and demonstrated. Experimental learning for clinical practice is included. *Prereq.: PTH 3570 Evaluation of the Neurologically Impaired Infant and Child.*

PTH 3800 Independent Study

Under the guidance and direction of a program adviser, students have the opportunity to develop and conduct projects related to their professional interests. *Prereq.: Written proposal and permission of program adviser.*

Speech-Language Pathology and Audiology

SLA 3600 Neurological Bases of Communication

This course will provide the student the opportunity to acquire a basic understanding of neuroanatomy and neurophysiology as they relate to normal aspects of speech, hearing, and language.

SLA 3601 Advanced Study in Articulation Disorders

An exploration into advanced theories of normal and abnormal phonological development with emphasis on distinctive theory and on phonetic theories of speech production; direct application of theories to diagnosis and treatment of various phonological disorders. *Prereq.: Undergraduate course in articulation disorders and permission of instructor.*

SLA 3602 Differential Diagnosis in Speech and Language Pathology

This course is designed to offer students the opportunity to learn formal and informal test procedures. *Prereq.: SLA 3603 Test Procedures in Speech and Language or permission of instructor.*

SLA 3603 Test Procedures in Speech and Language Pathology

The course is designed to offer students the opportunity to develop competence in administering and interpreting a variety of tests used in diagnosing communication disorders. Information relative to the case history and interview, as well as to formal test procedures and report writing, will be included. *Prereq.: Permission of instructor.*

SLA 3604 Language Disturbances in Children

This course will emphasize current theories in language behavior and their practical application to the assessment and remediation of language disturbances in children. Lectures, discussions, and case

presentations may focus on the following issues: what constitutes a language problem, what assessment tools and therapeutic techniques are currently available, and what underlying principles are involved in selecting and organizing the content of a remediation program. *Prereq.: SLA 3602 Differential Diagnosis in Speech and Language Pathology, SLA 3603 Test Procedures in Speech and Language Pathology, or permission of instructor.*

SLA 3605 Aphasia Rehabilitation

Emphasis on current attitudes toward therapy and new methods, clinical methods of evaluation which are preparatory to therapy, and observation of therapeutic methods. *Prereq.: SLA 3600 Neurological Bases of Communication and permission of instructor.*

SLA 3606 Clinical Management in Stuttering

This course will emphasize diagnostic techniques, a review of the current therapeutic approaches, consideration of the individual's need in therapy, and the process of behavioral and attitudinal change from within a psychodynamic framework. Also to be considered are termination, referral, and group therapy. *Prereq.: Permission of instructor.*

SLA 3607 Seminar: Speech Science

Study focuses on current physiological, acoustical, and perceptual data used to describe both normal and disordered speaking populations. Research techniques and instrumentation in the field of speech science are also examined. The application of theoretical information from speech science to the diagnosis and treatment of communicative disorders is discussed. *Prereq.: SLA 3875 and SLA 3876 Advanced Clinical Practice I and II.*

SLA 3608 Seminar: Voice Disorders

Etiology, symptomatology, and disorder complexes related to phonation. Special emphasis is placed on the philosophy and methods used in the assessment and treatment of voice disorders. *Prereq.: SLA 3602 Differential Diagnosis in Speech and Language Pathology and SLA 3603, Test Procedures in Speech and Language Pathology.*

SLA 3610 Audiology for Speech-Language Pathologists

This course provides speech-language pathology majors a review of standard procedures and an update of contemporary issues in audiology. Study focuses on pathological disruption of the auditory system and on assessment procedures currently applied and their relationship to patient management and treatment plans.

SLA 3620 Clinical Audiometry I

The use of pure tone and speech reception instrumentation in hearing evaluation; the interpretation of results in the diagnosis of functional and organic disorders. Lectures, demonstrations, observations, and practicum. *Prereq.: Introduction to Audiology and consent of instructor.*

SLA 3621 Medical Perspective to Anatomical Correlates in Audiology

This course provides the student with the opportunity for hands-on experience with dissection of human temporal bones as an approach to learning temporal bone anatomy; physiology and neurology are stressed. Students may become familiar with dissection techniques, use of dissecting microscope, and will be required to observe actual surgical procedures in a hospital. *Prereq.: Permission of department chairperson.*

SLA 3622 Pathologies of the Ear

Lectures and observations in the organic and neurological pathologies of the ear, e.g., otitis media, Meniere's disease, and otosclerosis. Consideration of approaches to treatment (medical setting). *Prep.: Permission of instructor.*

SLA 3623 Clinical Audiometry II

Specialized techniques (Bekey, EEG, site of lesion battery, BSR, ENG); the results and interpretation in the diagnosis of functional and organic hearing disorders. Lectures, demonstrations, and observations. *Prereq.: Introduction to Audiology and Audiometry I and permission of instructor.*

SLA 3624 Clinical Audiology

Physical characteristics of hearing aids and their performance. Theoretical approach to selection and fitting of hearing aids, and analysis of hearing aid dispensing systems. *Prereq.: Introduction to Audiology and permission of instructor.*

SLA 3625 Psychosocial Aspects of Communication Disorders

This course is concerned with the psychological, educational, and social aspects of communication disorders, particularly auditory impairment. *Prereq.: Permission of instructor.*

SLA 3626 Seminar in Audiology

Advanced study of the development of principles and theories associated with modern procedures and methods used in audiology. *Prereq.: Permission of instructor.*

SLA 3628 Psychoacoustics

This course offers the student the opportunity to explore the relationship between acoustic stimuli and psychological responses to sounds. Particular emphasis is placed on the similarities and differences in the perception of normal hearing and among different types of impaired hearing. Major topics of study include a general review of the physics of sound, detection, discrimination, masking, binaural hearing, and speech perception. *Prereq.: Permission of instructor.*

SLA 3629 Aural Rehabilitation

Various speechreading methods, auditory training techniques, and materials. An integrated approach to the treatment of the hearing handicapped.

SLA 3640 Cerebral Palsy

Neuromuscular involvements and concomitant language and speech disorders; intellectual deficits, psychological aspects, communicative disorders of a cerebral palsied population; testing, placement, and management of the cerebral palsied child with emphasis on a multidisciplinary approach. *Prereq.: Permission of instructor.*

SLA 3641 Physiological Acoustics

Particular emphasis is placed on the biophysics of the hearing mechanism, especially in terms of actual clinical utility. Comparative anatomy and physiological analysis are stressed. *Prereq.: Introductory courses in Speech and Hearing, and permission of instructor.*

SLA 3642 Seminar: Orofacial Anomalies

Etiology, symptomatology, and problems associated with orofacial anomalies. Emphasis will be placed on the speech, language, and hearing characteristics and the assessment and treatment of persons with orofacial anomalies. Psychological and social considerations and analysis of the team habilitative effort will be presented.

SLA 3643 Seminar in Speech Pathology

Individual research and/or critical review of the literature in some area of basic science, speech sound learning, language, voice, fluency, or multiple disorders, with special emphasis on the impact of deafness on psychosocial development. Class presentation of material and class discussion may be included. *Prereq.: Open to graduate students who have completed the equivalent of two quarters of graduate work in Speech Pathology and have the instructor's permission.*

SLA 3645 Neuropathology

Application of functional neuroanatomy in comprehending the various disease processes involving the nervous system; cerebrovascular disease tumors or malformations, Parkinson's disease, multiple sclerosis, and others. *Prereq.: Permission of instructor.*

SLA 3647 Hearing Science Seminar

Individual research and/or critical review of the literature in the area of bone conduction of auditory signals, evoked response and audiometry, impedance and audiometry, cortical processing of auditory input, and other related topics. Students will be responsible for class presentations of researched material. *Prereq.: Permission of instructor.*

SLA 3650 Medical Perspective to Anatomical Correlates in Speech Pathology

This course will provide the opportunity for hands-on experience with dissection of human larynxes as an approach to learning voice tract anatomy. Students may become familiar with dissection techniques, use of dissecting microscope, and may have an opportunity to observe actual surgical procedures in a hospital. *Prereq.: Permission of department chairperson.*

SLA 3651 Social Dialectology: Theoretical and Educational

This course focuses on the social and cultural influences on the language behavior and communication needs of the culturally "different" child. It emphasizes the interrelationship between linguistic structure and social structure and its implications for clinical intervention. *Prereq.: Permission of instructor.* *

SLA 3652 Behavior Modification: Operant Procedures in Speech and Language Training

This course reviews principles and procedures of the functional analysis of behavior and focuses upon the application of behavioral theory and research to speech, language, and hearing training. It emphasizes clinical investigation in the experimental analysis of behavior of communication disorders and experiences in the application of experimental procedures in assessment and treatment programs. *Prereq.: Permission of instructor.*

SLA 3653 Seminar: Communication Disorders

This course provides an exploration into the development of communication and communication disorders, with focus on early conversational interaction, children's discourse, and pragmatic intents. Emphasis is placed on deficient social bases and their effect on language performance as well as trends for clinical procedures and intervention strategies for language-disordered children. Communication is viewed as the ultimate goal of therapy. Course participants are expected to complete a research project on the development of communication and child discourse and its application to clinical assessment and intervention.

SLA 3690 Seminar in Normal Language Acquisition

This seminar will assess current theories and designs of studies of language acquisition and processing from infancy through adolescence. Special problems in data collection and analysis in the various areas of child language will be discussed

through lectures, student presentations, and discussions of current research. Methodology, data, and results of current research and their significance to theories of language acquisition will be critiqued using video-taped and audio-taped data samples. Each student will be expected to write a research proposal to investigate a specific topic in language acquisition.

SLA 3691 Sociolinguistics

This course will consist of basic sociolinguistic concepts including dialectal variation and other forms of language variation, attitudes toward language use and the speech community; language needs of multicultural children in educational settings, considering cultural attitudes of teachers and types of learning situations available; and social and cultural diversity and its effects on the individual's communicative competence. Also included will be methods of sociolinguistic research that will lead to the student designing a language study for application in: discourse analysis; language in the classroom; sociolinguistic effects on reading, writing, oral language, and role relationships.

SLA 3698 Workshop in Speech Pathology and Audiology

(See general workshop description on page 86.)

SLA 3699 Institute in Speech Pathology and Audiology

(See general institute description on page 86.)

SLA 3800 Directed Study

This experience is provided for the student whose unique academic needs or interests cannot be adequately satisfied in any of the scheduled courses of the department. Not available to special students. *Prereq.: Approval of the chairperson of the department and of the director of the graduate school. (Approval forms must be submitted during the quarter prior to registration of the Directed Study.)*

SLA 3801 Thesis

A research activity that may be selected by the student in lieu of two courses (8 quarter hours), with the approval and recommendation of the adviser.

SLA 3875 Advanced Clinical Practice I (2 Q.H.)

A two-quarter sequence of supervised clinical experience in speech pathology and audiology designed for beginning graduate students. Practicum sites include the Northeastern University Hearing, Language, and Speech Clinic; satellite clinics; and/or educational settings. Students must be available a minimum of two days per week during the academic year. This course also requires attendance at on-campus seminar meetings held twice a month. *Prereq.: Permission of clinical staff.*

SLA 3876 Advanced Clinical Practice II (3 Q.H.)

A two-quarter sequence of supervised clinical practicum in speech pathology and audiology at the Northeastern University Hearing, Language, and

Speech Clinic; medical settings; educational settings; and rehabilitation centers. Practicum experience emphasizes advanced diagnostic and management techniques stressing the application of theory to practice. Students must be available a minimum of two days per week during the academic year. *Prereq.: SLA 3875 Advanced Clinical Practice I and permission of clinical staff.*

SLA 3877 Advanced Clinical Practice III (3 Q.H.)
A two-quarter sequence of supervised clinical practicum in speech pathology and audiology designed for advanced graduate students. Practicum experience emphasizes problem-solving techniques relevant to case management. Students must be available a minimum of two days per week during the academic year. *Prereq.: SLA 3876 Advanced Clinical Practice II and permission of clinical staff.*

Interdepartmental Courses

INT 3500 Research Design and Methodology

Research methods and designs used in health education, physical education, physical therapy, and recreation education. Emphasis is placed on the development of research techniques, including the ability to define research problems; write hypotheses; review and interpret literature; apply research designs; organize, analyze, and present data; and draw relevant conclusions. *Prereq.: Statistics or permission of instructor.*

INT 3540 Computer Applications for Nonprofit Organizations

An introductory course which presents ways in which generic software packages (database management, spreadsheets, business graphics, and word processing) may be used to improve efficiency and effectiveness of individuals and organizations. Hardware and software configurations are discussed.

INT 3549 Introduction to Computer Programming: FORTRAN

A laboratory course designed to develop facility in the use of a wide range of data-processing equipment in educational research. Students will be introduced to the basic principles of computer programming, but emphasis will be placed on the applicability and use of existing statistical programs.

INT 3550 Instruction in LOGO

Philosophy and programming in the LOGO language form the primary emphases. Curriculum materials are demonstrated showing the use of the LOGO language in areas such as computer programming, mathematics, and language arts. Current research and applications of LOGO in the school curriculum are presented. Creation of individual LOGO projects in laboratory settings are required.

INT 3551 Instructional Programming in PASCAL

An introduction to computers and computer programming using the language PASCAL. Tools such as text editors are also discussed. Instructional applications are made where possible.

INT 3552 Computer Use for Educators (2 Q.H.)

Designed for educators with minimal computer experience, this course provides an introduction to word processing, data processing and file management. Functions of the operating system and the physical hardware are discussed. The BASIC programming language will be introduced. Students will have extensive hands-on experience in class and through accompanying supervised laboratories.

INT 3553 Word Processing for Educators (2 Q.H.)

A variety of word processing software programs are taught. Applications of word processing ranging from simple one-page letters to documents and mail-merge are considered in this course. Students will have extensive hands-on experience with computers in class and through accompanying supervised laboratories.

INT 3554 Computers in Education

This course will focus on the use of computers both as a teaching methodology and as an administrative tool in education. The use of Computer Assisted Instruction (CAI) will be introduced through the BASIC programming language. A variety of microcomputer software packages suitable for classroom and administrative use will be tested in a laboratory setting. Extensive hands-on experience with a number of commercially available educational software packages is required. Strategies and methods for integrating computing within the elementary and secondary curriculum are highlighted.

INT 3555 Introduction to Computer Use for Professionals

Introduction to computer capabilities and limitations; selection of hardware/software; use of a line editor; introduction to system command language; and introduction to data processing through a packaged library program such as SPSS, BDMP, MINITAB or IMSL.

INT 3556 Educational Applications of DBMS

Several general purpose software packages (database, spreadsheet, and data analysis) and simulations are used for working through such problems as scheduling/facilities usage, recordkeeping and general ledger/accounting, and survey/market research.

INT 3557 Instruction in LOGO II

This course represents a second course in the LOGO environment, emphasizing advanced concepts in LOGO, including the use of list-processing in language, music, physics, and mathematics. *Prereq.: INT 3550.*

INT 3501 Thesis/Project I

Initiation of a scholarly investigation. Students are required to submit a written research proposal for approval by a thesis/project committee and to pres-

ent an oral proposal at a college seminar. *Prereq.: ED 3340, INT 3500, completion of two courses in area of concentration, and permission of program adviser.*

INT 3502 Thesis/Project II

The investigation proposed in Thesis/Project I implemented with, and culminating in, an approved written report in thesis form. *Prereq.: INT 3501 Thesis/Project I.*

INT 3503, 3504 Seminar/Workshop

Special seminars or workshops on interdepartmental topics of timely interest. Graduate credit may be granted for successful completion of a workshop, but credit may not be applied toward a degree program without the program adviser's approval. A maximum of eight quarter hours earned in seminars or workshops may be applied toward the degree.

Institutes

ED 3828, ED 3825, ED 3826, ED 3827, CRS 3803, SLA 3699, CRS 3805, CRS 3804, HSL 3898, HSL 3822, PTH 3801

A department may offer a special institute in a specific field of interest from time to time. The institute may be collaborative, offered by the several departments in the Boston-Bouvé College of Human Development Professions, and will usually include a special institute faculty drawn from resources outside the University, as well as from the Boston-Bouvé faculty. The institute focuses on a specific area of academic study and may be interdisciplinary in nature; it involves total time commitments on the part of participants in morning, afternoon, and evening sessions, five or six days per week, for one to eight

weeks, depending upon the nature and scope of the institute. Institutes are customarily designed for participants who are currently employed in a common field of work and wish to receive additional preparation in new methods, new materials, and new content areas. Graduate credit may be granted for successful completion of an institute but may not be applied toward a degree program at the University without the approval of the departments in which students are doing their major field of specialization degree work. All institute participants must be degree candidates in the graduate school or must qualify, prior to registration, as special graduate students. *Prereq.: Permission of institute instructor.*

Workshops

ED 3820, ED 3821, ED 3822, ED 3823, CRS 3806, SLA 3698, CRS 3808, CRS 3807, HSL 3899, HSL 3823, PTH 3802

A department may offer a special workshop in a specific field of interest from time to time. Emphasis in the workshop is focused on the development of instructional materials or the resolution of practical problems with a single school or institutional setting. Workshops may also be held for a group of potential participants who are currently employed in a com-

mon field of work. Graduate credit may be granted for successful completion of a workshop but may not be applied toward a degree program at the University without the approval of the departments in which students are doing their major field of specialization degree work. All workshop participants must be degree candidates in the graduate school or must qualify, prior to registration, as special graduate students. *Prereq.: Permission of workshop instructor.*

Professional Accounting

Graduate School of Professional Accounting

ACC 3401 Accounting Problems I

5 Q.H.

An accelerated introduction to the basic accounting process and the preparation of general-purpose financial statement. Specific topics covered include cash, investment, receivables, inventories, current liabilities, and present value concepts. Completion of a self-instructed, programmed text on the basic accounting concepts.

ACC 3402 Cost Accounting Theory and Problems

5 Q.H.

Specialized problems of cost accumulation and cost behavior are analyzed. Specific topics covered include: cost-volume-profit analysis, standard costs and budgeting, overhead analysis, and capital budgeting. Costs involved in managerial decision-making are given special attention.

ACC 3404 Accounting Problems II

5 Q.H.

A continuation of ACC 3401 including coverage of the following topics: plant, property and equipment, depreciation, long-term liabilities, stockholders, equity, earnings per share, and accounting for income taxes.

ACC 3405 Accounting Problems III

3 Q.H.

An examination of specialized accounting topics including pensions, leases, accounting changes, statement of changes in financial position, partnerships, and government accounting.

ACC 3406 Advanced Accounting Problems

3 Q.H.

An examination of business combinations including the purchase and pooling methods. Specific topics covered include: intercompany profits, indirect and reciprocal holdings, and foreign currency translations.

ACC 3407 Auditing Theory and Practice

5 Q.H.

An examination of auditing concepts, standards, and procedures. Topics covered include: the legal and ethical responsibilities of the auditor, statistical sampling, auditing and EDP, audit reports, and audit procedures. Emphasis is given to concepts and to understanding the nature and objectives of the audit process.

ACC 3408 Federal Income Tax Accounting

6 Q.H.

A comprehensive study of the Internal Revenue Code, regulations, revenue rulings, and relevant cases. Emphasis is placed on taxation of individuals, corporations, partnerships, estates and trusts, tax-planning considerations, and tax research.

ACC 3413 Contemporary Accounting Theory

5 Q.H.

An examination of current issues and trends in accounting that are of greatest concern to the accounting profession. The concepts and developments of the accounting profession. The concepts and developments of the theoretical aspects of accounting are explored. Authoritative pronouncements of various accounting organizations are examined.

FIN 3414 Management of Financial Resources

5 Q.H.

The financial management of corporations and the principles governing the effective management of capital. The various sources of funds—short-, intermediate-, and long-term—are discussed in detail, using selected cases for illustrative purposes. Financial institutions such as the Securities and Exchange Commission (SEC), and the securities markets are also studied.

HRM 3403 Organizational Behavior

5 Q.H.

An examination of behavior in business organizations. However, this knowledge is also applicable to nonprofit organizations such as schools, government agencies, and hospitals, including community groups, and social clubs. Students are given an opportunity to acquire knowledge of behavior and develop skill in dealing with it, and as they hope to affect and change it.

MEC 3412 Managerial Economics Quantitative Approach

5 Q.H.

Decision-making under conditions of uncertainty: allocation of scarce resources, utilizing linear programming models, determination of the value of a marginal unit of a scarce resource (concept of shadow price), sensitivity analysis, examination of the most frequently encountered sampling distributions, determination of optimal decision rules, and economic models for estimating demand-and-cost relationship.

MGT 3415 Business Law

5 Q.H.

Contracts, partnerships, corporations, agency, commercial paper, sales, and other topics essential for professional development in the business and legal environment.

MGT 3416 Business Policy in a Societal Setting

5 Q.H.

Cases focus on business decisions confronting management. Examines policy decisions and their impact on various sectors of society, such as stockholders, customers, suppliers, the public and government.

MKT 3410 Marketing

5 Q.H.

Introduction to managing the marketing activities of an organization. Examination of the basic marketing management systems: marketing research, the marketing organizational system, and the marketing planning and control system. Topics include customer/client analysis, market research, product/service planning, pricing, communications, advertising and sales promotion, distribution management, and the development of strategies. Course relies mainly on case study discussions of actual marketing decisions, supplemented by lectures and readings.

MSC 3409 Operations Management

4 Q.H.

An introductory, graduate-level course emphasizing the organization and management of productive sys-

tems. The goal is to provide an introduction to the nature and types of organizations and management techniques used to control operations. The three major types of productive systems, which are flow, job, and project, are offered, focusing on standards, capacity, scheduling, inventory, and control.

MSC 3411 Information Systems 4 Q.H.

A nontechnical introduction to computers and information systems, focusing on issues relevant to audit and control. The first portion of the course delves into basic computer and information-systems concepts, including computer hardware, software, and systems development. Following this aspect, emphasis is placed on managing, planning, and controlling the computer resource, security and privacy issues,

and computer auditing. Students will be expected to have become familiar with elementary computer programming and the use of Northeastern's time-sharing terminals.

MSC 3420 Computer Programming: An Introduction 0 Q.H.

The information systems course (MSC 3411), scheduled for the spring quarter, presumes that students will have acquired an understanding of the art of computer programming, which uses the language referred to as BASIC. This noncredit course is designed to provide the necessary background for students having inadequate preparation. Offered on a pass-fail basis, the course may be waived by permission of the instructor.

Computer Science

Graduate School of Computer Science

COM 3200 Computer Architecture 4 Q.H.

Organization of machines and computations. Computer System capacity. Processors. Control units. Memories and memory hierarchies. Interconnection networks. Different computer architectures are studied by examining the corresponding languages and assemblers.

COM 3205 Software Design and Development 4 Q.H.

Students work in groups to organize, manage and implement a large scale programming project. Topics considered are: software planning; software methodologies, e.g., functional decomposition, data flow design, data structure design, programming calculus; several large examples of program design; software testing and reliability. *Prereq.: COM 1201 or equivalent.*

COM 3315 Database Management Systems I 4 Q.H.

Concepts and structures necessary to design and implement a DBMS application. Introduction to database concepts. Database modeling. Hierarchical, network and relational models. Data definition and manipulation languages. Design theory for relational models. Query optimization. Integrity, security, recovery and concurrency in database systems. *Prereq.: MTH 3510, COM 1310, COM 1315 or equivalent.*

COM 3316 Database Management Systems II 4 Q.H.

Specification, design and implementation of a simple DMBS. Practical database design issues and methodology. Discussion of conceptual implementation and physical design. Techniques to evaluate design alternatives and tradeoffs. Analysis of primary and secondary access methods for performance of database operations and for storage space. *Prereq.: COM 3315.*

COM 3336 Operating Systems 4 Q.H.

Design and implementation of an operating system. Algorithms for concurrent processes, deadlock resolution, process management, performance evaluation and monitoring. Students work on a project implementing a small operating system or extending an existing one. *Prereq.: An undergraduate operating systems or systems programming course.*

COM 3350 Theory of Computation 4 Q.H.

Formal models of computation including Turing machines and partial recursive functions; Turing-decidability and unsolvable problems. Computational complexity, the class P and NP, some NP-complete problems. *Prereq.: COM 1350 or equivalent.*

COM 3355 Compiler Construction I 4 Q.H.

Advanced concepts and principles of compiler design including an overview of compiler structures. Topics also cover: syntax-directed compilation, translation and interpretation, the relation between

syntax and semantics, the relation between high level programming languages and compilers, between finite state machines and lexical analysis, between context-free languages, parsing trees and the syntactic specification of programming languages and some parsing techniques such as shift-reduce parsing, operator-precedence parsing, top-down parsing and predictive parsers. Selected current research papers and articles are used as references.

COM 3356 Compiler Construction II 4 Q.H.

Further investigations of compiler construction including principles of syntax-directed translation, simple SDTS and top-down transducers, simple postfix SDTS and bottom-up transducers. Topics like bottom-up parsing, LR(k), LALR parsing, code generation, symbol table structures, error detection and recovery and code optimization are also discussed. Selected current papers and articles are used for discussion.

COM 3370 Advanced Computer Graphics 4 Q.H.

Selected advanced topics in computer graphics chosen from the following list: area fill algorithms, the aliasing problem in line drawing, 3 dimensional graphics, geometric transforms, hidden surface algorithms, curve and surface approximation techniques, solid primitives, color and shading, approaches to obtaining realistic images. *Prereq.: An introductory course in computer graphics.*

COM 3390 Analysis of Algorithms 4 Q.H.

Design and analysis of fast algorithms. Topics are chosen from: 1) Advanced data structures: representing partitions, union-find algorithms, priority queues; 2) Graph algorithms: biconnectivity, maximum flow, shortest path, matching, minimum spanning tree; 3) Algebraic problems: Matrix multiplication, polynomial multiplication, string matching, linear programming; 4) Probabilistic algorithms: tests for primality, factoring polynomials and integers. *Prereq.: COM 1201, COM 1390, MTH 1409 or MTH 1410, MTH 1301 or MTH 3102 or equivalent.*

COM 3420 Knowledge Representation and Inferencing 4 Q.H.

Knowledge representation, acquisition and utilization. Frames, scripts, conceptual dependency. Forward and backward chaining, unification and resolution, non-monotonic reasoning. Rote learning, learning by analogy, consistency checking. *Prereq.: COM 1410 or equivalent.*

COM 3430 Expert Systems 4 Q.H.

Architectures used in the design of expert systems. Survey of current systems. Use of system building tools such as ROSIE. Nature of expertise in a domain. Symbols, search, reasoning. Production systems. *Prereq.: COM 1410 or equivalent.*

COM 3440 Natural Language Processing 4 Q.H.

Essentials of natural language understanding and production. Focus is on semantic and pragmatic

issues rather than syntactic or phonological. Elements in the design of NL human-computer interfaces. Dialog control. Lexical-semantic relations, semantic primitives, and the structure of text. *Prereq.: COM 3420*

COM 3450 Syntactic Pattern Recognition 4 Q.H. Introduction to syntactic pattern recognition and comparison with the classical discriminant approach. A survey of various syntactic pattern recognition techniques, such as picture descriptive languages (PDL), formal grammars, array grammars, tessellation structures, sequential/parallel matrix grammars, and histogram approaches. Syntax analysis as a recognition procedure. Grammatical inference for syntactic pattern recognition. Applications of syntactic pattern recognition to selected problems in industry, the military, and business, including robotics. *Prereq.: COM 1350 or equivalent.*

COM 3460 Intelligent Computer-Assisted Instruction 4 Q.H.

The notion of course material independent of teaching procedures. Problems and comments individualized for each student. System tutor with reactive learning environments. Examples for SCHOLAR and GUIDON. Group development of intelligent instructional systems. *Prereq.: COM 3420.*

COM 3510 Computer Communication Networks: Design & Performance 4 Q.H.

A study of interacting computers. Topics include: elementary queueing theory, connectivity theory, data link and transport protocols, slot rings, token rings and CSMA, routing algorithms, performance analysis of networks. Additional topics may be chosen from models of networks or of network protocols, error detection and correction, applications protocols such as virtual terminal or file transfer protocols. *Prereq.: COM 1201, MTH 1387, MTH 1409 or MTH 1410*

COM 3520 Cryptography and Computer Security 4 Q.H.

Design and use of cryptographic systems and cryptanalytic attacks; a history of cryptographic systems and the mathematics behind them; shift register sequences; random number generators; DES; public key systems and their applications. *Prereq.: COM 1350, MTH 1387, MTH 1409 or MTH 1410, MTH 1390 or equivalent.*

COM 3560 Distributed Database Systems 4 Q.H. A consideration of the problems and opportunities inherent in distributed data bases on a network of computer systems. Includes file allocation, directory systems, deadlock detection and prevention synchronization, query optimization, and fault tolerance. *Prereq.: COM 3316, COM 3510*

COM 3570 Office Automation 4 Q.H.

The structure and impact of telecommunications and distributed processing on management information systems and decision support systems. Electronic mail systems, teleconferencing, and videotex. Micro-computer networks, network software, and operating systems. *Prereq.: COM 3510.*

COM 3580 Principles of Interactive Systems Design 4 Q.H.

Principles for optimal design of interactive systems such as text editors, programming environments, automated banking systems and commercial products for nontechnical users such as decision support systems, word processors, personal computers, etc. User characteristics which impact systems design. Impact of current technologies such as touch screens, mice and other pointing devices, sophisticated graphics, data integration, etc., on interaction style. Survey of styles of interaction including menus, command languages, forms fill-in. Object-oriented vs. application-oriented interfaces. Optimizing design tradeoffs.

COM 3585 Methods in Interactive Systems Design 4 Q.H.

Survey of the research and methodology in the design of interactive systems. Introduction to experimental methodologies applied in the study of styles of interaction: field studies, controlled laboratory experiments, protocol analysis. Survey and critique of research on various aspects of interaction such as dialogue style, filing and retrieval mechanisms, command languages, menu design, input devices, message and error handling and screen layout. *Prereq.: COM 3580.*

COM 3630 Concurrent Programming 4 Q.H.

The logical problems that arise in concurrency and their machine implementations. Mutual exclusion, message passing, deadlock, monitors, kernels, and applications to operating systems. *Prereq.: COM 3336.*

COM 3640 Parallel Computation 4 Q.H.

Algorithms and theories for parallel computation on fixed-connection networks and on concurrent systems having a fixed number of processors. Included are algorithms for sorting, priority queues, graph algorithms, matrix multiplication, and FFT. Students use a network of micros to implement some of these algorithms. Applications to VLSI design may be included. *Prereq.: COM 3336, COM 3390.*

COM 3800 Readings in Computer Science 4 Q.H.

Selected readings under the supervision of a faculty member. *Prereq.: Core courses and permission of instructor.*

COM 3810 Special Topics in Computer Science

Faculty will lecture on current topics in computer science. Topics will vary from quarter to quarter. May be taken up to three times for credit, with changes in topics. *Prereq.: Core courses or permission of instructor.*

COM 3820 Computer Science Master's Thesis

May be repeated for credit. *Prereq.: Agreement of a thesis advisor.*

COM 3830 Computer Science Master's Project

May be repeated for credit. *Prereq.: Agreement of a project supervisor.*

COM 3840 Seminar in Computer Science

Students will read and present various survey and research papers in Computer Science. Faculty supervisor and topics will vary from quarter to quarter. May be repeated for credit. *Prereq.: Core courses or permission of instructor.*

Criminal Justice

Graduate School of Criminal Justice

The following course descriptions, listed numerically by area of concentration, are representative of the courses offered in the graduate Criminal Justice program. As it is not possible to offer all courses each year, students are urged to consult the most current announcement of course offerings for specific information regarding available courses in any given quarter. All courses described here carry three quarter-hours of credit.

CJ 3201 The Criminal Justice Process

An analysis of the criminal justice process from crime prevention and arrest to release after incarceration, emphasizing a legal, sociological, and policy approach to criminal justice. The philosophies, practices, procedures, and issues of agencies involved in criminal justice are reviewed. Critical attention is also given to different approaches to crime control.

CJ 3202 Theories of Criminology

Focuses on the use of scientific methods in the study and analysis of regularities, uniformities, patterns, and causal factors related to crime, the criminal, and social reactions to both. Critical contributions to the study of crime, criminals, and the treatment of offenders are analyzed as they emerge from writings in such disciplines as biology, psychology, psychiatry, endocrinology, law, sociology, and anthropology.

CJ 3203 Criminal Law

The fundamental principles and concepts of criminal law in the United States. This course focuses on the relationship of the individual to the state and includes an examination of the general framework of criminal law.

CJ 3204 Statistical Analysis I

Introduction to probability and statistics. Topics to be covered include measures of central tendency and dispersion; probability and the binomial, Poisson, exponential, and normal distributions; sampling distributions and hypothesis testing; and correlation and regression.

CJ 3205 Evaluation Methods in Criminal Justice

Focuses on some of the nontechnical, yet crucial, research issues including ethical problems, the design, procedures, and politics of evaluation research in criminal justice, as well as funding sources and the generation and administration of grants and contracts. Students are expected to participate in evaluation exercises and to prepare proposal narratives and budgets.

CJ 3251 Criminal Justice Planning and Development

An examination of planning techniques and their impact on criminal justice program development, currently and for the future. An analysis of policy and decision making pertaining to criminal justice organizations and agencies is developed as is the extent of planning for crime control at local, state, regional, and national levels. The peculiar nature of urban problems in relation to planning is also reviewed, involving identifying problem areas in the field of criminal justice, diagnosing their causes, and

formulating solutions. In addition, the course examines alternative strategies and mobilization of resources necessary to effect change in the system.

CJ 3252 Criminal Justice Management

Examines the theory of management and applied skills in the field of management. Strong emphasis will be put upon the development of systems skills in getting people to work together to achieve a common objective. Students will be given the opportunity to develop their skills in applying the concepts of planning, managing, motivating, and controlling in a management environment. The major emphasis in the course will be upon the development of knowledge and skills in the area of situational analysis and problem solving in applying both systems theory and functional theory.

CJ 3253 Personnel and Labor Relations in Criminal Justice

This course helps to provide the student with basic skills in personnel management, selection, and placement. It is also intended to help students develop an understanding of the social psychology of organizations concerned with law enforcement, the courts, or corrections, and to help them develop familiarity with critical issues in labor relations and collective bargaining.

CJ 3254 Budget and Financing in Criminal Justice

The principles and practices of budgeting in the various functional areas of criminal justice. Financial operations are dealt with in depth, including such matters as obtaining resources through budget development and presentation. Distinctions between capital budgets and expense budgets and among zero budgeting, line-item budgeting, and program budgeting are drawn. Important financial concerns such as cost effectiveness, management by objectives, and critical path method (CPM) are discussed. Special attention is given to budget projections as planning tools for obtaining grants, as well as a means of facilitating needed change within the present structures of criminal justice agencies. The utility of budgets as evaluative mechanisms is stressed; and the role of budgeting in the financial control of organizations is discussed.

CJ 3301 Administration of Private Security

A comprehensive overview of private security theories, operations, and practices, with special emphasis on the administration and management of security. The philosophical background, history, and current role of private security are explored, as well as the role and status of the security manager in threat assessment, risk prevention, and the protec-

tion of assets. Functional-area security systems, law, science and technology for security, and issues, standards, goals, and challenges for the future are dealt with in the course. Security systems are considered, particularly as these "open" systems related to criminal justice and the environment. The security manager is conceived of as the prime mover toward professionalization and improved management and administration of security operations, and as the advocate of contemporary organizational theories embracing research and the systems approach.

CJ 3302 Law and Private Security

The legal factors that affect security operations and administration and the value of legal counsel on such factors. These factors include the pertinent aspects of torts, agency, civil rights, contracts, trade secrets, patents and copyrights, insurance, and regulatory issues.

CJ 3303 Technological Security Systems

Considers security applications of the latest scientific and technological advances and the impact of new product developments on prevention and protection, detection, and prosecution. Students will examine the state of the art of security products and are invited to plan, implement, maintain, and evaluate highly sophisticated security systems.

CJ 3304 Human Factors in Security

An analysis of topics and strategies for security administration. Executive development, ethical issues, stress management, conflict management, crisis management, intra-organizational relations, community agency relations, promoting security awareness, staff development, and effective security personnel and product interface are addressed.

CJ 3351 Theories of Law and Society

An introduction to theories, issues, and research related to law and legal institutions, placing law in the context of social control systems, raising basic issues about the nature of law, and focusing on the relationship between law and social values. The course also considers the nature of law, law and social change, the sociology of the legal profession, and criminal law in action. Attention is given to the formulation of criminal law and discrimination in the formulation and practice of criminal law.

CJ 3352 Statistical Analysis II

A continuation of Statistical Analysis I. Multiple regression and its extensions, discriminant analysis, factor analysis, analysis of variance, and the analysis of contingency tables are discussed. *Prereq.: HCJ 1204.*

CJ 3353 Research Methods in Criminal Justice

A survey of methodological approaches to criminal justice research. Various research strategies, including sample surveys, observation, historical research, experiments, and evaluation, are discussed and highlighted with examples from the literature. Also reviewed are various sources of criminal justice data with assessments of their reliability and validity. Var-

ious data analytic strategies, including tabular analysis and nonparametric methods, are emphasized within the context of computer assignments.

CJ 3354 Criminal Behavior Systems

This course examines offender and offense patterns within nine general crime categories: (1) violent personal, (2) conventional property, (3) public order, (4) political, against the government, (5) political, by the government, (6) occupational, (7) "organized," (8) professional, and (9) sexual. The course is intended to serve as a detailed introductory survey to help familiarize graduate students with a broad range of crime types and criminal behavior systems as well as some of their classic and contemporary analyses.

CJ 3511 Theories of Delinquency

Examines critically the major theoretical explanations of juvenile delinquency. Theoretical approaches include social disorganization, subcultural theory, strain, control theory, labeling and conflict theory. In addition, current data on the nature and distribution of delinquency are discussed, and findings from empirical research are highlighted.

CJ 3512 Penology and Corrections

The meaning and efficacy of punishment, the history of imprisonment, the structure of prisons, the effectiveness of treatment, the rights of prisoners, and sentencing policy are discussed.

CJ 3513 Victimology

Critically examines theories and research regarding victims of crime. Special attention is devoted to an analysis of National Crime Survey victimization data. Also concepts such as fear of crime, victim vulnerability, and victim culpability are discussed. In addition, implications of victim-oriented research for the administration of justice are assessed, as are current programs offering victim services such as restitution and compensation. Future trends in theory, research, and public policy are analyzed.

CJ 3514 Police Functions in Democratic Society

An examination of the sociopolitical context within which American police departments developed in the nineteenth century as well as the changing forces that shape modern departments. Considers the implications of democratic institutions and traditions for policing in America. The organization of several different kinds of departments are contrasted, and the implications of these different types of departments for police performance are examined. The rigors of police work, together with the social-psychological adjustments that officers at different ranks make, is also considered.

CJ 3515 Women and the Criminal Justice System

An examination of the roles of women in the criminal justice system. The course focuses on women as offenders, as victims, and as agents of social control; on both theory and practice, and on both historical and contemporary issues.

CJ 3516 Court Management and Administration

The organization and structure of the courts, including the problems, policies, and practices of the criminal court system. Particular emphasis is placed on the lower criminal court. Issues in court management, including personnel problems, scheduling, role of juries and witnesses, use of planning and management techniques, and court reform, are reviewed.

CJ 3517 Terrorism

Divided into two sections, the first part of which examines the sociology of terrorism, including funding, intelligence gathering, weapons and tactics, informers, and countermeasures. Special attention is also given to the media which report the news, yet seem often perilously close to inciting further terror. The "terrorist personality," the literary depiction of terrorism, and the doctrine of systematic terrorism, as well as its current interpretations and common patterns, motives, and aims, are also examined.

The second part concentrates on identifying technologies of counterterrorism, discussing incident management needs, and recommending ways to lessen the risk of nationally disruptive acts. The course attempts to challenge accepted assumptions and to forecast changes in terrorist activities that may affect tomorrow's headlines.

CJ 3518 Issues in Juvenile Justice

A critical analysis of the policies and practices of agencies involved in processing young people through the juvenile justice system. Specific attention is devoted to police practices, detention, intake, diversion, adjudication, and disposition of juveniles within the justice system. In addition, the course focuses on the historical development of the juvenile justice system and assesses current trends and proposals for reform.

CJ 3519 Organized Crime

The course approaches organized crime from a law enforcement perspective, stressing, however, the general criminal justice implications. The corruptive influences of organized crime are dealt with, as well as aspects of overzealous enforcement that may lead to violations of constitutional safeguards. The scope of intelligence activities and the role of computerized information concerning organized crime are explored with special attention given to sensitive privacy issues involved. Problems of definition, organizational structure, operating methods, participant identification, and legal limitations are discussed. The effect of so called "victimless crime" status in enhancing the economic viability and public tolerance of organized crime is also considered, and present strategies suggested for the control or elimination of this pervasive phenomenon. Finally, the relationship of organized crime to the continuing increase of both "street" and "white collar" crime is assessed.

CJ 3520 Conflict Management

An examination of problems in conflict management, including concepts and definitions of social conflict and comparisons between functional and dysfunction-

al conflict. Inquiries into representative conflict management strategies and techniques are made, affording the opportunity to relate general theory and research results to practical situations of criminal conflict management. The course generally relies on a variety of heuristic techniques, including scenarios, role playing, and the use of audiovisual media.

CJ 3521 Probation and Parole

An examination of the nature, objectives, means, and problems of probation and parole administration and management.

CJ 3523 Law Enforcement and the Community

This course examines the nature, problems, and present procedures associated with police-community relations in order to develop more efficient and effective policing. The course utilizes the lecture-forum technique with assigned readings, group discussions, and project development and critiquing.

CJ 3524 Theories of Punishment

An overview of theories and issues in punishment with a focus on topics of contemporary interest as well as the historical roots of current approaches. Trends and fashions in both the theory and the form of punishment are considered. Reading materials are drawn from a variety of fields, including philosophy, politics, literature, law, and empirical criminal justice.

CJ 3503 Criminal Evidence

An introduction to the field of criminal evidence. Students are expected to read and brief cases and must be prepared to discuss them in class. The readings, class lectures, and discussions help familiarize students with the various procedures and rules related to the trial of a criminal case.

CJ 3505 Juvenile Law and Children's Rights

An examination of the legal relationship between the juvenile offender and the state. The course covers case and statutory law, as well as constitutional due-process standards in juvenile proceedings. Areas covered include jurisdiction, prejudicial process, waiver of jurisdiction adjudication, disposition, and postdispositional issues, including right to treatment.

CJ 3506 Criminal Procedures

Constitutional issues of the administration of criminal justice. Topics to be considered include selected provisions of the United States Constitution, with particular emphasis on Amendments 4, 5, 6, and 14, and on questions of electronic surveillance, right to counsel, line-up, bails, and right to speedy trial.

CJ 3508 Quantitative Models in Criminal Justice

Quantitative frontiers in the field of criminal justice as well as the methodological contributions of allied fields are examined: in particular, such approaches as reliability models of recidivism, stochastic models of criminal behavior, econometric models of the criminal justice system, and deterrence models are addressed. An extensive coverage of published and unpublished literature is central to the course.

CJ 3509 Crime Measurement

The amount, distribution, and pattern of criminal behavior in the United States are examined via official crime statistics including the Uniform Crime Reports, victimization surveys, and self-report studies. Alternative measures including indices of seriousness of various offenses are reviewed. Attention is also devoted to historical studies of the nature and extent of criminal behavior. Finally, problems and prospects regarding accurate measures of crime and crime correlates are discussed.

CJ 3510 Computer Applications in Criminal Justice

An introduction to the computer and its applicability to criminal justice, research, and operations. Topics covered include command language, file creation and editing, data storage modes, introductory FORTRAN, simulation, graphics, and word processing. Course requirements include a series of computer assignments concerning criminal data and problems.

CJ 3525 Correctional Administration

An intensive coverage of the many problems and dilemmas which confront the correctional organization. Topics for discussion include such issues as basic problems of correctional organization, organizational development and analysis, management by objectives, planning and budgeting systems, management style and personnel development, special problems of jails and houses of corrections, institutional programs, classifications, correctional policy, and the future of imprisonment.

CJ 3527 Community Corrections

This course examines the concepts of community corrections, utilizing historical, philosophical, and pragmatic perspectives and including an analysis of the alternatives to imprisonment or institutionalization. For course purposes, community-based programs are defined as programs aimed at reducing the occurrence of criminal and delinquent behavior through prevention, rehabilitation, reintegration, and/or diversionary services in noninstitutional settings which make maximum use of existing and potential community resources.

CJ 3529 Comparative Criminology

Crime and its control from the comparative perspective, viewed both historically and contemporaneously. The development of Roman legal institutions, the emergence of common law and other legal systems (the civil law and the socialist legal system), and the emergence of American legal institutions in the nineteenth century are all examined. The crime problems

in developing societies (India, nineteenth-century Europe and America) are contrasted with those in developed societies (modern Europe and America), and the impact of a world economic system on the two is explored. The advantages of comparative analysis are developed.

CJ 3531 White Collar Crime

This course is designed to examine critically the current theoretical, research, and public policy issues regarding white collar crime. The first part examines definitions of white collar crime as well as various typologies of white collar crime activity. The nature, extent and consequences of white collar crime in the United States will also be assessed. Finally, explanations for the commission of these offenses will be discussed. The second part uses case studies to explore in more detail white collar crime. For example, cases of employee theft, corporate crime, governmental deviance, industrial espionage, and computer crime will be presented and discussed. The third part focuses on controlling white collar crime. The problems of traditional criminal justice systems in controlling white collar crime will be examined and the prospects of alternative systems of control—civic law, private security, public opinion—will be assessed.

CJ 3801, CJ 3802 Directed Study I and II

An independent study offers the student the opportunity to bring individual, concentrated attention to a particular topic as arranged and agreed upon in advance by a faculty member and the student. This option is generally recommended when the student desires a more intensive analysis of a particular subject. The independent study has the advantage of allowing students flexibility in learning and developing their own academic programs.

CJ 3803, CJ 3804 Internship I and II

Field instruction in a criminal justice agency where instruction may be offered through administrative, research, teaching and/or related activities. Students have the opportunity to apply theoretical concepts in a practical, applied fashion by observing and contributing to the daily activities of operating agencies and organizations.

CJ 3805 Master's Thesis

Students electing to write a Master's thesis must select a thesis topic with the advice of a faculty member and receive approval of the thesis topic from the graduate director.

Engineering

Graduate School of Engineering

Chemical Engineering

Each course description includes information on the expected quarter in which classes are usually offered. The quarters listed are presented here for planning purposes; however, the Graduate School of Engineering cannot guarantee that all courses will be offered. Students must refer to the Graduate School of Engineering Quarterly Course Offering sheets to determine what courses are actually offered in any given quarter and at what day and time.

CHE 3300 Chemical Engineering Mathematics (formerly 04.802) 4 Q.H.

Fall Quarter, Alternating Years

Formulation and solution of problems involving advanced calculus as they arise in chemical engineering situations. Methods covered will be ordinary differential equations, series solutions, complex variables. Laplace transforms, partial differential equations, and matrix operations. Emphasis will be placed on methods for formulating the problems. It will be assumed that the student has been exposed to some of these topics in appropriate mathematics courses. *Prereq.: BS degree in Chemical Engineering including mathematical analysis.*

CHE 3301 Chemical Engineering Mathematics 2 Q.H.

Fall Quarter, As Announced

CHE 3301 and CHE 3302 cover the same material with the same prerequisites as CHE 3300, but in two 2QH courses.

CHE 3302 Chemical Engineering Mathematics II 2 Q.H.

Winter Quarter
Continuation of CHE 3301. *Prereq.: CHE 3301.*

CHE 3310 Chemical Engineering Thermodynamics I (formerly 04.811) 4 Q.H.

Winter Quarter, Alternating Years

Classical thermodynamics as a method of approach to the analysis of processes of interest to chemical engineers. A study of phase equilibria involving the various states of matter; prediction and correlation of physical, chemical, and transport properties of gases and liquids; elementary concepts of quantum and statistical mechanics to interpret the empirical properties of classical thermodynamics. Fundamental principles are reviewed to the extent needed. *Prereq.: BS degree in Chemical Engineering.*

CHE 3311 Chemical Engineering Thermodynamics I 2 Q.H.

Winter Quarter

CHE 3311 and CHE 3312 cover the same material with the same prerequisites as CHE 3310, but in two 2QH courses.

CHE 3312 Chemical Engineering Thermodynamics II 2 Q.H.

Spring Quarter

Continuation of CHE 3311. *Prereq.: CHE 3311.*

CHE 3320 Separation Process (formerly 04.978) 4 Q.H.

Spring Quarter, Alternating Years

Calculation and design methods used in processes involving mass transfer. Topics covered include vapor liquid equilibria for binary and multicomponent systems, multicomponent distillation, absorption and extraction. Emphasis is placed on methods and techniques which are common to many separation processes. *Prereq.: BS degree in Chemical Engineering.*

CHE 3321 Separation Processes I 2 Q.H.

Winter Quarter

CHE 3321 and CHE 3322 cover the same material with the same prerequisites as CHE 3320, but in two 2QH courses.

CHE 3322 Separation Processes 2 Q.H.

Spring Quarter

Continuation of CHE 3321. *Prereq.: CHE 3321.*

CHE 3330 Chemical Process Control (formerly 04.829) 4 Q.H.

Fall Quarter, Alternating Years

Review of classical control techniques; state variable representation and analysis of continuous control systems in chemical engineering, including controllability, observability, and stability. Multivariable control problems in chemical engineering; introduction to optimal control. Digital simulation included where appropriate. *Prereq.: Graduate standing in Chemical Engineering or permission.*

CHE 3331 Chemical Process Control I 2 Q.H.

Fall Quarter, As Announced

CHE 3331 and CHE 3332 cover the same material with the same prerequisites as CHE 3330, but in two 2QH courses.

CHE 3332 Chemical Process Control II 2 Q.H.

Winter Quarter

Continuation of CHE 3331. *Prereq.: CHE 3331.*

CHE 3340 Heterogeneous Catalysis (formerly 04.890) 4 Q.H.

Winter Quarter, Alternating Years

Experimental methods required for determining the surface area and pore structure of catalyst carriers are discussed. These structural characteristics are utilized to estimate mass and heat transport rates within porous catalyst in order to determine their effectiveness with respect to chemical reaction.

Mechanisms for chemical poisoning of catalysts are also analyzed. Reactions of practical interest are used to illustrate the applications of heterogeneous catalysis to modern chemical processing problems. *Prereq.: BS degree in Chemical Engineering.*

CHE 3341 Heterogeneous Catalysis I 2 Q.H.
Winter Quarter

CHE 3341 and CHE 3342 cover the same material with the same prerequisites as CHE 3340, but in two 2QH courses.

CHE 3342 Heterogeneous Catalysis II 2 Q.H.
Spring Quarter

Continuation of CHE 3341. *Prereq.: CHE 3341.*

CHE 3350 Chemical Process Heat Transfer 4 Q.H.
(formerly 04.973)

Spring Quarter, Alternating Years

Empirical methods and calculations used to design heat transfer equipment for the chemical process industries. Review of basic heat transfer principles. Shell-and-tube calculations for liquid and/or vapor phase heat transfer. Direct contact and other special heat exchanger applications. *Prereq.: BS degree in Chemical Engineering.*

CHE 3351 Chemical Process Heat Transfer I 2 Q.H.

Winter Quarter

CHE 3351 and CHE 3352 cover the same material with the same prerequisites as CHE 3350, but in two 2QH courses.

CHE 3352 Chemical Process Heat Transfer II 2 Q.H.

Spring Quarter

Continuation of CHE 3351. *Prereq.: CHE 3351.*

CHE 3400 Advance Chemical Engineering Calculations (formerly 04.801) 4 Q.H.

As Announced

Fundamental process principles leading to an understanding of the stoichiometric principles of chemical process plants. The study of complex material and energy balances is undertaken with the view to apply these principles to actual large chemical plant conditions. *Prereq.: BS degree in Chemical Engineering including differential equations.*

CHE 3401 Advanced Chemical Engineering Calculations I 2 Q.H.

As Announced

CHE 3401 and CHE 3402 cover the same material with the same prerequisites as CHE 3400, but in two 2QH courses.

CHE 3402 Advanced Chemical Engineering Calculations II 2 Q.H.

As Announced

Continuation of CHE 3401. *Prereq.: CHE 3401.*

CHE 3410 Numerical Techniques in Chemical Engineering (formerly 04.803) 4 Q.H.

Fall Quarter, As Announced

Digital computer applications to chemical engineering problems. Topics covered include location of roots

of linear and nonlinear equations, numerical integration, and curve-fitting techniques with emphasis on the numerical solution of ordinary and partial differential equations and to the subject of linear algebra. *Prereq.: BS degree in Chemical Engineering.*

CHE 3411 Numerical Techniques in Chemical Engineering I 2 Q.H.

Fall Quarter, As Announced

CHE 3411 and CHE 3412 cover the same material with the same prerequisites as CHE 3410, but in two 2QH courses.

CHE 3412 Numerical Techniques in Chemical Engineering 2 Q.H.

Winter Quarter

Continuation of CHE 3411. *Prereq.: CHE 3411.*

CHE 3430 Chemical Data Estimation 2 Q.H.
(formerly 04.832)

As Announced

Methods of obtaining physical and thermodynamic properties of chemical compounds and systems without resorting to laboratory investigation. Latest empirical relationships and physical and thermodynamics laws are introduced to obtain data for plant design and other chemical and engineering uses. *Prereq.: BS degree.*

CHE 3450 Analytical and Numerical Techniques (formerly 04.835) 4 Q.H.

As Announced

For students interested in solving comprehensive problems using computer methods. Problems solved in the course will be based on the interest of the students and staff and will be individual. *Prereq.: BS degree and knowledge of digital computer programming.*

CHE 3500 Transport Phenomena (formerly 04.823) 4 Q.H.

Winter Quarter, As Announced

Momentum rate conservation equations for steady-state fluid flow in two-dimensional boundary layers are presented and solved to obtain the fluid velocity profiles. These results are utilized in the consideration of heat and mass transfer phenomena at a fluid-solid interface. The development of surface renewal theory is presented and applied to the description of heat and mass transfer phenomena. *Prereq.: BS degree in Chemical Engineering.*

CHE 3501 Transport Phenomena I 2 Q.H.

Winter Quarter

CHE 3501 and CHE 3502 cover the same material with the same prerequisites as CHE 3500, but in two 2QH courses.

CHE 3502 Transport Phenomena II 2 Q.H.

Spring Quarter

Continuation of CHE 3501. *Prereq.: CHE 3501.*

CHE 3510 Modeling and Simulation of Chemical Process (formerly 04.837) 4 Q.H.
Winter Quarter, Alternating Years
 Use of special purpose and general purpose computer programs in solving the steady-state material and energy balances of chemical processes. Course includes related background material which may be applied to these computer programs such as convergence acceleration for calculations involving recycle streams, tearing recycle streams for iteration on minimum number of streams and minimum number of parameters, and algorithms for design variable selection. *Prereq.: Graduate standing in Chemical Engineering.*

CHE 3511 Modeling and Simulation of Chemical Process I 2 Q.H.
Winter Quarter
 CHE 3511 and CHE 3512 cover the same material with the same prerequisites as CHE 3510, but in two 2QH courses.

CHE 3512 Modeling and Simulation of Chemical Process II 2 Q.H.
Spring Quarter
 Continuation of CHE 3511. *Prereq.: CHE 3511.*

CHE 3520 Computer Process Control (formerly 04.830) 4 Q.H.
Winter Quarter, Alternating Years
 Computer control hardware and software. Z-transform, pulse transfer functions, and data holds. Open and closed-loop response and design of sampled-data systems. Computer control algorithms. Digital simulation of sampled data systems. *Prereq.: Graduate standing in Chemical Engineering or permission.*

CHE 3521 Computer Process Control I 2 Q.H.
Winter Quarter
 CHE 3521 and CHE 3522 cover the same material with the same prerequisites as CHE 3520, but in two 2QH courses.

CHE 3522 Computer Process Control II 2 Q.H.
Spring Quarter
 Continuation of CHE 3521. *Prereq.: CHE 3521.*

CHE 3530 Advanced Management Techniques in the Chemical Industry (formerly 04.840) 4 Q.H.
Fall Quarter, Alternating Years
 Management techniques applied to the chemical industry. Special attention to management of research organizations and to management of engineering services, such as design, computer, and related activities. *Prereq.: Graduate standing.*

CHE 3531 Advanced Management Techniques in the Chemical Industry I 2 Q.H.
Fall Quarter, As Announced
 CHE 3531 and CHE 3532 cover the same material with the same prerequisites as CHE 3530, but in two 2QH courses.

CHE 3532 Advanced Management Techniques in the Chemical Industry II 2 Q.H.
Winter Quarter
 Continuation of CHE 3531. *Prereq.: CHE 3531.*

CHE 3540 Advanced Process Design Concepts (formerly 04.845) 4 Q.H.
Spring Quarter, Alternating Years
 This course stresses techniques and approaches used in the development of new or improved processes. Topics include establishment of process bases, use of process simulators in design, optimization and evaluation of alternatives, and preliminary equipment design and cost estimating techniques. *Prereq.: BS degree in Chemical Engineering.*

CHE 3541 Advanced Process Design Concepts I 2 Q.H.
Fall Quarter, As Announced
 CHE 3541 and CHE 3542 cover the same material with the same prerequisites as CHE 3540, but in two 2QH courses.

CHE 3542 Advanced Process Design Concepts II 2 Q.H.
Winter Quarter
 Continuation of CHE 3541. *Prereq.: CHE 3541.*

CHE 3543 Advanced Plant Design Concepts II 2 Q.H.
Spring Quarter
 Modern approaches to plant design: computer-oriented design, analysis and simulation of chemical processes, use of strategy decision making in design, advanced scheduling and planning techniques. *Prereq.: BS degree in Chemical Engineering.*

CHE 3560 Fluid Mechanics (formerly 04.974) 4 Q.H.
Fall Quarter, Alternating Years
 Discussion of statics, kinematics, and stress concepts associated with fluids. Formation of the general equations of motion with application to laminar and turbulent flow. Topics on boundary layer theory and compressible flow are included. *Prereq.: BS degree in Chemical Engineering.*

CHE 3561 Fluid Mechanics I 2 Q.H.
Fall Quarter, As Announced
 CHE 3561 and CHE 3562 cover the same material with the same prerequisites as CHE 3560, but in two 2QH courses.

CHE 3562 Fluid Mechanics II 2 Q.H.
Winter Quarter
 Continuation of CHE 3561. *Prereq.: CHE 3561.*

CHE 3600 Polymer Science (formerly 04.870) 4 Q.H.
Fall Quarter, Alternating Years
 Basic concepts of polymers, thermodynamics of polymer solutions and measurement of molecular weight. Physical and chemical testing of polymers. Crystallinity in polymers and rheology of polymers. Physical

and chemical properties of polymers. Mechanisms and conditions for polymerization of polymers including step-reaction, addition and copolymerization. Discussion of carbon-chain polymers, fibers and fiber technology. *Prereq.: BS degree in Chemical Engineering or Chemistry.*

CHE 3601 Polymer Science I 2 Q.H.
Fall Quarter, As Announced

CHE 3601 and CHE 3602 cover the same material with the same prerequisites as CHE 3600, but in two 2QH courses.

CHE 3602 Polymer Science II 2 Q.H.
Winter Quarter

Continuation of CHE 3601. *Prereq.: CHE 3601.*

CHE 3620 Principles of Polymerization 4 Q.H.
(formerly 04.872)

Fall Quarter, Alternating Years

Introduction to polymers and polymer properties. Mechanisms of polymerization including step polymerization, radical-chain polymerization, emulsion polymerization, ionic-chain polymerization, chain copolymerization and ring-opening polymerization. Stereo chemistry of polymerization and synthetic reactions of polymers. Applications to reactor design of industrially important polymers. *Prereq.: Graduate standing in Chemical Engineering.*

CHE 3621 Principles of Polymerization I 2 Q.H.
Fall Quarter

CHE 3621 and CHE 3622 cover the same material with the same prerequisites as CHE 3620, but in two 2QH courses.

CHE 3622 Principles of Polymerizations II 2 Q.H.
Winter Quarter, As Announced

Continuation of CHE 3621. *Prereq.: CHE 3621.*

CHE 3630 Chemical Process Pollution 4 Q.H.
Control (formerly 04.850)

Spring Quarter, Alternating Years

Provides chemical engineering students with basic fundamentals for handling environmental problems in the chemical process industries. Water quality requirements and industrial waste characteristics; wastewater treatment processes applicable to environmental engineering; biological treatment processes and equipment; comprehensive design problems involving biological and tertiary treatment; the economics of water treatment and reuse. *Prereq.: Graduate standing in Chemical Engineering.*

CHE 3631 Chemical Process Pollution 2 Q.H.
Control I

Winter Quarter

CHE 3631 and CHE 3632 cover the same material with the same prerequisites as CHE 3630, but in two 2QH courses.

CHE 3632 Chemical Process Pollution 2 Q.H.
Control II

Spring Quarter

Continuation of CHE 3631. *Prereq.: CHE 3631.*

CHE 3660 Solar Energy Thermal 2 Q.H.
Processes (formerly 04.862)

Fall Quarter

Covers fundamental thermal processes involved in obtaining useful heat from flat-plate solar collectors. The components required in an active solar energy collection system are analyzed, and the economics of the system are considered. *Prereq.: BS degree.*

CHE 3663 Fundamentals of Polymer 4 Q.H.
Processing (formerly 04.871)

Winter Quarter, Alternating Years

Transport properties of polymer solutions and polymer melts. Modeling and design of polymer processing equipment. Flow models for processes involving heat, mass, and/or momentum transfer. Analysis of flow stability and elastic phenomena. Applications to the design of equipment for extrusion, calendering, coating, fiber spinning, tubular film blowing, injection molding and mixing. *Prereq.: Graduate standing in Chemical Engineering.*

CHE 3664 Fundamentals of Polymer 2 Q.H.
Processing I

Winter Quarter

CHE 3664 and CHE 3665 cover the same material with the same prerequisites as CHE 3663, but in two 2QH courses.

CHE 3665 Fundamentals of Polymer 2 Q.H.
Processing II

Spring Quarter

Continuation of CHE 3664. *Prereq.: CHE 3664.*

CHE 3670 Special Topics in Chemical 4 Q.H.
Engineering (formerly 04.899)

As Announced

Topics of interest to the staff member conducting this class are presented for advanced study. A student may not take more than one Special Topics course with any one instructor. *Prereq.: Permission of department staff.*

CHE 3671 Kinetics of Chemical Processes 2 Q.H.
(formerly 04.891)

Spring Quarter, Alternating Years

The theoretical foundations for the analysis of elementary chemical reaction rates, such as collision theory, particle dynamics, and transition state theory are presented. Consideration is given to the theory of monomolecular reactions and the effect of solvent and electrostatic forces on liquid phase reaction rates. Homogeneous catalysis and selected free-energy correlations are covered. *Prereq.: BS degree in Chemical Engineering.*

CHE 3672 Kinetics of Chemical 2 Q.H.
Processes I

Winter Quarter

CHE 3672 and CHE 3673 cover the same material with the same prerequisites as CHE 3671, but in two 2QH courses.

CHE 3673 Kinetics of Chemical Processes II Spring Quarter Continuation of CHE 3672. <i>Prereq.: CHE 3672.</i>	2 Q.H.	CHE 3799 PhD Continuation (formerly 04.9X4) Any Quarter	0 Q.H.
CHE 3680 Corrosion Fundamentals (formerly 04.821) As Announced Economic factors, basic theories, types, behaviors of specific systems, and protection against corrosion are studied. Wherever possible, engineering applications of the principles are emphasized. <i>Prereq.: BS degree.</i>	2 Q.H.	CHE 3860 Thesis (Master's Degree) (formerly 04.991) Any Quarter Analytical and/or experimental work conducted under the supervision of the department. <i>Prereq.: Graduate Standing in Chemical Engineering.</i>	10 Q.H.
CHE 3690 Seminar (formerly 04.990) Any Quarter Topics of an advanced nature are presented by staff, outside speakers, and students in the graduate program. This course must be attended by all master's degree candidates. <i>Prereq.: Graduate standing in Chemical Engineering.</i>	2 Q.H.	CHE 3861 Thesis (Master's Degree) Any Quarter	4 Q.H.
CHE 3796 DEng Continuation Any Quarter	0 Q.H.	CHE 3862 Thesis (Master's Degree) Any Quarter	2 Q.H.
CHE 3798 Masters Thesis Continuation (formerly 04.9X1) Any Quarter	0 Q.H.	CHE 3880 Thesis (PhD Degree) (formerly 04.995) Any Quarter Theoretical and experimental work conducted under the supervision of the department. <i>Prereq.: Admission to doctoral program in Chemical Engineering.</i>	0 Q.H.
		CHE 3885 Thesis (DEng Degree) (formerly 04.996) Any Quarter Theoretical and experimental work conducted under the supervision of the department. <i>Prereq.: Admission to program in Chemical Engineering.</i>	0 Q.H.

Civil Engineering

Each course description includes information on the expected quarter in which classes are usually offered. The quarters listed are presented here for planning purposes; however, the Graduate School of Engineering cannot guarantee that all courses will be offered. Students must refer to the Graduate School of Engineering Quarterly Course Offering sheet to determine what courses are actually offered in any given quarter and at what day and time.

CIV 3131 Engineering Statistics I (formerly 01.916) Fall Quarter The basic elements of probability theory and statistics and their use via the solution of various civil engineering problems encountered in fluid mechanics, construction management, structures, transportation. Probability of events, random variables and distributions, derived distributions, expectation, common probability models. <i>Prereq.: Undergraduate calculus.</i>	2 Q.H.	problems. Examples are drawn from structural mechanics. <i>Prereq.: Admission to the Graduate School of Engineering.</i>
CIV 3132 Engineering Statistics II (formerly 01.917) Winter Quarter Continuation of CIV 3131. Includes parameter estimation, confidence intervals, hypothesis testing, and linear statistical models. <i>Prereq.: CIV 3131.</i>	2 Q.H.	CIV 3142 Numerical Methods in Civil Engineering II (formerly 01.889) Winter Quarter Continuation of CIV 3141. Approximation of functions: interpolation, and least squares curve fitting; orthogonal polynomials. Numerical differentiation and integration. Solution of ordinary and partial differential equations, and integral equations; discrete methods of solution of initial and boundary-value problems. Examples are drawn from structural mechanics, geotechnical engineering, hydrology and hydraulics. <i>Prereq.: CIV 3141.</i>
CIV 3141 Numerical Methods in Civil Engineering I (formerly 01.888) Fall Quarter Introduction, errors in numerical analysis. Solution of nonlinear algebraic equations by direct and iterative methods. Introduction to matrix eigenvalue	2 Q.H.	CIV 3151 Environmental Impact Statement Process I (formerly 01.865) Fall Quarter This course provides a pragmatic introduction to the legal/regulatory framework that determines the content and format of environmental documents and presents an overview of the techniques used to identify and evaluate environmental impacts. <i>Prereq.: Admission to Graduate School of Engineering.</i>

CIV 3152 Environmental Impact Statement Process II (formerly 01.866) 2 Q.H.
Winter Quarter

This course supplements the information on procedures and analysis encompassed in CIV 3151 by setting forth state-of-the-art techniques for quantification of environmental effects and development of measures to mitigate identified adverse impacts. *Prereq.: CIV 3151.*

CIV 3155 Technology Assessment (formerly 01.988) 2 Q.H.
Winter Quarter

Classical views of technology. History and definition of technology assessment. Individual, environmental and societal impacts of technologies. Technological externalities. Risks and the determination of safety. Policy options for dealing with technological problems. Case studies. *Prereq.: Admission to the Graduate School of Engineering and consent of instructor.*

CIV 3161 System Analysis I (formerly 01.807) 2 Q.H.
Fall Quarter

Application of linear optimization models to various civil engineering problems: the simplex method, sensitivity analysis, transportation problem, transshipment problem, shortest path problem. *Prereq.: Admission to Graduate School of Engineering.*

CIV 3162 Systems Analysis II (formerly 01.808) 2 Q.H.
Winter Quarter

Further application of systems analysis techniques to civil engineering problems: dynamic programming, linear regression, model estimation, queuing theory, project evaluation. *Prereq.: CIV 3162 and CIV 3131; to be taken concurrently with CIV 3132.*

CIV 3163 Systems Analysis III (formerly 01.809) 2 Q.H.
Spring Quarter

Further application of techniques and approaches presented in CIV 3161 and CIV 3162. New topics to be presented include integer programming, non-linear programming, simulation, decision analysis. Other topics may be added according to interest, as time allows. Aim will be to help prepare students to complete a term project employing numerous techniques of systems analysis. *Prereq.: CIV 3163.*

CIV 3231 Construction Management I (formerly 01.821) 2 Q.H.
Fall Quarter

This course treats cost estimating, including a description of computerized cost estimating systems; duration estimating, considering work analysis techniques; value engineering as a concept and its effect on the construction industry; and specifications, including the use and importance of computerized Specification Writing Systems. *Prereq.: Admission to Graduate School of Engineering.*

CIV 3232 Construction Management II (formerly 01.822) 2 Q.H.
Winter Quarter

This course contains treatment of the application of scheduling methods to the control of construction activities including resource allocation, quality control, cash flow progress reporting, and the effects of change orders. *Prereq.: CIV 3231.*

CIV 3237 Construction Methods and Equipment I (formerly 01.830) 2 Q.H.
Fall Quarter

This course treats typical approaches to construction in a selection of application areas such as steel and concrete structures, hydraulic and port facilities, horizontal construction and the like. *Prereq.: Admission to Graduate School of Engineering.*

CIV 3238 Construction Methods and Equipment II (formerly 01.831) 2 Q.H.
Winter Quarter

This course is a continuation of CIV 3237, treating additional areas of construction. *Prereq.: CIV 3237.*

CIV 3241 Legal Aspects of Civil Engineering (formerly 01.832) 2 Q.H.
Fall Quarter

A presentation of United States and international legal systems and theories necessary for the comprehension of business and contractual liabilities, rights and obligations in the engineering field. *Prereq.: Admission to the Graduate School of Engineering.*

CIV 3242 Legal Aspects of Civil Engineering II (formerly 01.833) 2 Q.H.
Winter Quarter

This course deals with the description and evaluation of various types of construction contracts, procedures and formats for submitting bids, filing claims, and legal steps to avoid liabilities, utilizing the principles learned in CIV 3241. *Prereq.: CIV 3241.*

CIV 3245 Construction Seminar (formerly 01.827) 2 Q.H.
Spring Quarter

This course is a reading and discussion course centering on recent research publications in Construction Engineering. *Prereq.: Limited to Construction Management Program majors; to be taken in final spring quarter.*

CIV 3310 Environmental Chemistry I (formerly 01.920) 2 Q.H.
Fall Quarter

A review of basic chemistry is followed by a discussion of the equilibrium chemistry of homogeneous and heterogeneous systems with applications in environmental engineering. The physical and chemical properties of water are studied, as are acidity, alkalinity, hardness, and water softening. Topics in receiving water quality and disinfection are included. *Prereq.: Two quarters of general chemistry.*

CIV 3311 Environmental Chemistry II 2 Q.H.
(formerly 01.921)**Winter Quarter**

Continuation of CIV 3310, including the basic principles of chemical thermodynamics, electrochemistry, kinetics, organic chemistry, biochemistry, and nuclear chemistry as they relate to environmental engineering. Colloidal chemistry and coagulation are discussed as are fundamental water quality parameters such as BOD, COD, and TOC. *Prereq.: CIV 3310; to be taken concurrently with CIV 3325.*

CIV 3312 Environmental Chemistry I 4 Q.H.
and II (formerly 01.923)**Fall Quarter**

This course embodies the material in CIV 3310 and CIV 3311. *Prereq.: Two quarters of general chemistry.*

CIV 3315 Water and Wastewater 2 Q.H.
Treatment I (formerly 01.910)**Fall Quarter**

Water quality, water impurities and effects, the theory and practice of water treatment, and the elements of design of water treatment works including intake facilities, wells, coagulation, sedimentation, filtration, softening, iron and manganese removal, disinfection and fluoridation. *Prereq.: Undergraduate fluid mechanics and CIV 3311.*

CIV 3316 Water and Wastewater 2 Q.H.
Treatment II (formerly 01.911)**Winter Quarter**

Waste characteristics, the theory and practice of wastewater treatment and disposal, and the elements of design of primary and secondary treatment works, including screening, grit removal, sedimentation, biological treatment processes, sludge digestion and disposal, stabilization ponds, and disinfection. *Prereq.: CIV 3315.*

CIV 3317 Water and Wastewater 2 Q.H.
Treatment III (formerly 01.912)**Winter and Spring Quarters**

Desalination, advanced wastewater treatment, land treatment, effluent disposal and reuse, small alternative wastewater systems, and other special problems in water and wastewater characteristics and treatment, including corrosion control, and application and storage of chemicals. *Prereq.: CIV 3316 or CIV 3318.*

CIV 3318 Water and Wastewater 4 Q.H.
Treatment I and II (formerly 01.914)**Fall Quarter**

This course embodies the material in CIV 3315 and CIV 3316. *Prereq.: Undergraduate fluid mechanics; to be taken concurrently with CIV 3312.*

CIV 3320 Environmental Microbiology 2 Q.H.
(formerly 01.922)**Winter and Spring Quarters**

A study of microbiology with emphasis on environmental engineering applications. The course includes cell structure, nutrition, morphology, growth, reproduction, and metabolism of microorganisms of

environmental significance. Effects of environmental factors including inhibition, killing, and natural habitats are discussed. In addition, anaerobic digestion and eutrophication are covered. *Prereq.: CIV 3311; to be taken concurrently with CIV 3326.*

CIV 3325 Environmental Analysis I 2 Q.H.
(formerly 01.930)**Winter Quarter**

A laboratory course for the analytical evaluation of environmental conditions. Included are coagulation studies, chlorine demand determination, and the use of colorimetric spectroscopy. Interpretation of analytical results for practical applications is also stressed. *Prereq.: CIV 3310; to be taken concurrently with CIV 3311.*

CIV 3326 Environmental Analysis II 2 Q.H.
(formerly 01.931)**Spring Quarter**

Laboratory analyses are continued with emphasis on the chemical and biological analyses associated with wastewater treatment methods. Nitrogen determinations are included. Gas chromatography and atomic absorption spectroscopy are used for trace analyses of organics and metals. *Prereq.: to be taken concurrently with CIV 3312.*

CIV 3327 Environmental Analysis I and II 4 Q.H.
(formerly 01.933)**Fall Quarter**

This course embodies the material in CIV 3325 and CIV 3326. *Prereq.: to be taken concurrently with CIV 3312.*

CIV 3341 Industrial Waste Disposal 2 Q.H.
(formerly 01.913)**Fall and Spring Quarter**

Evaluation of industrial waste problems and development of process design for the required treatment facilities; study of various manufacturing processes and their wastewater problems; industrial waste survey techniques; characteristics of industrial wastes; evaluation of hazardous materials; waste reduction methods; physical, chemical, biological and advanced treatment methods; industrial wastewaters and disposal and treatment of industrial solids and liquids. *Prereq.: CIV 3311 and CIV 3317.*

CIV 3343 Unit Operations in 2 Q.H.
Environmental Engineering I (formerly 01.935)**Winter Quarter**

Laboratory scale unit operations illustrating the physical, chemical and biological principles involved in water and wastewater treatment. The aim is to obtain criteria for system design. Topics include disinfection, water softening, sedimentation, chemical coagulation, and ion exchange. *Prereq.: CIV 3317 and CIV 3326.*

CIV 3344 Unit Operations in 2 Q.H.
Environmental Engineering II (formerly 01.936)**Spring Quarter**

Continuation of CIV 3343. Topics include biodegradability studies using activated sludge, fixed-film

reactors, anaerobic digestion, vacuum filtration, and chemical-physical processes involved in wastewater treatment. A comprehensive evaluation of each unit process is required in a report from each student. *Prereq.: CIV 3343.*

CIV 3345 Unit Operations in Environmental Engineering I and II (formerly 01.938) 4 Q.H.

Spring Quarter

This course embodies the material in CIV 3343 and CIV 3344. *Prereq.: CIV 3317 and CIV 3326 or CIV 3327.*

CIV 3348 Stream Sanitation (formerly 01.954) 2 Q.H.

Winter Quarter

Analysis of the fate and effects of discharge of conservative and nonconservative pollutants in surface receiving waters and groundwaters. Topics include BOD and oxygen relationships in streams, eutrophication and general water quality improvement techniques. *Prereq.: CIV 3310.*

CIV 3351 Open Channel Flow I (formerly 01.902) 2 Q.H.

Fall Quarter

Open channel flow classification; energy and momentum principles; uniform flow calculations; design of channels for uniform flow; channel transitions; gradually varied flow; surface profile computations; spatially varied flow. *Prereq.: Undergraduate fluid mechanics and hydraulic engineering.*

CIV 3352 Open Channel Flow II (formerly 01.903) 2 Q.H.

Winter Quarter

Rapidly varied flow, hydraulic jump and its applications; flow through nonprismatic channel sections; flow in channels of nonlinear alignment, wave action; unsteady flow, dynamic equations; wave propagation; flood routing in rivers. *Prereq.: CIV 3351.*

CIV 3355 Hydrology I (formerly 01.908) 2 Q.H.

Winter Quarter

Elements of the hydrologic cycle, precipitation, evaporation, streamflow, groundwater; water balance equation for watersheds; streamflow hydrographs, unit hydrographs, hydrographs of overland flow; relation between precipitation and runoff; hydrologic and hydraulic routings, linear reservoirs routing. *Prereq.: CIV 3131 and undergraduate fluid mechanics and hydraulic engineering.*

CIV 3356 Hydrology II (formerly 01.909) 2 Q.H.

Spring Quarter

Deterministic hydrologic models; probability in hydrology; stochastic hydrology, generation of data, Markov chain series; flood forecasting; applications of hydrology and design considerations. *Prereq.: CIV 3132 and CIV 3355.*

CIV 3358 Flow Through Porous Media (formerly 01.924) 2 Q.H.

Fall Quarter, Alternate Years

Groundwater uses; properties of porous media; infiltration, saturated and unsaturated zones, soil water interactions; types of aquifers; Darcy's law, Dupuit-Forchheimer's assumption, groundwater flow equations, steady and unsteady cases; steady state seepage problems, method of flow nets; dispersion of groundwater, quality and contamination of groundwater. *Prereq.: Undergraduate fluid mechanics and hydraulic engineering.*

CIV 3360 Groundwater and Seepage (formerly 01.925) 2 Q.H.

Winter Quarter, Alternate Years

Hydraulics of wells, steady and transient flow equations, pumping tests, multiple well systems, methods of images; superposition, leaky aquifers, salt-water intrusion, static equilibrium and hydrodynamic equilibrium, control of saline water intrusion; numerical and experimental methods, physical models, analog models, finite difference solution, introduction to the method of finite elements. *Prereq.: CIV 3358.*

CIV 3363 Hydraulic Structures I (formerly 01.963) 2 Q.H.

Fall Quarter, Alternate Years

Reservoirs, characteristics, capacity, sedimentation, waves and floods; forces on dams; types of dams; gravity dams; earth dams; arch dams; cofferdams; turbines. *Prereq.: Admission to Graduate School of Engineering.*

CIV 3364 Hydraulic Structures II (formerly 01.964) 2 Q.H.

Winter Quarter, Alternate Years

Intake structures; outlet structures, spillways; tunnels; canals; offshore protection. *Prereq.: CIV 3363.*

CIV 3367 Water Resources Planning (formerly 01.965) 2 Q.H.

Spring Quarter, Alternate Years

The nature of water resources projects (sociopolitical, legal); water resources planning objectives (economic, cost, benefit); problems in water resources engineering (development, design, operational, recapitulation); introduction to linear and dynamic programming; simulation methods; case studies. *Prereq.: CIV 3141 and CIV 3355.*

CIV 3370 Air Pollution Engineering (formerly 01.950) 2 Q.H.

Winter Quarter

Theory and practice related to engineering management of air resources; applications of models for the atmospheric dispersion of pollutants; analysis of control systems for gaseous and particulate emissions utilizing dry collection, wet collection, absorption, and catalytic processes. Discussion of source control evaluation and air quality standards. Course CIV 3374 is recommended. *Prereq.: Admission to Graduate School.*

CIV 3372 Air Sampling and Analysis 2 Q.H.
(formerly 01.955)**Spring Quarter**

A laboratory course in air pollution measurements utilizing physical, chemical and instrumental methods and calibration and use of sampling equipment for gaseous and particulate pollutants. Identification and quantitative measurements of pollutants are performed utilizing microscopy, spectrophotometry, gas chromatography, and atomic absorption spectroscopy. *Prereq.: CIV 3370.*

CIV 3374 Air Pollution Science 2 Q.H.
(formerly 01.957)**Fall Quarter**

Biological and chemical aspects of air pollution with emphasis on the toxicological aspects of the environment, physiological effects of aerosols, analysis of organic and inorganic constituents of the atmosphere and rationale for establishment of air quality criteria and standards. Note: This course is open to non-engineering as well as to engineering graduate students. *Prereq.: Consent of the department and instructor.*

CIV 3376 Industrial Hygiene 2 Q.H.
(formerly 01.952)**Winter Quarter**

Characterization and control of industrial problems associated with noise, heat and ventilation. Physical and biological aspects of environmental stress are discussed. Emphasis is placed on the application of engineering principles to the design of control systems. Evaluation procedures for control effectiveness are reviewed. *Prereq.: Admission to Graduate School of Engineering.*

CIV 3378 Environmental Planning and Management 2 Q.H.
(formerly 01.980)**Fall Quarter**

Planning and operation, and management of specific environmental systems, such as collection systems; solids separators, combined systems control, sewer flushing, deposition loadings with least-squared applications, and case studies in optimal design of treatment plants with variable input. *Prereq.: Admission to Graduate School of Engineering.*

CIV 3380 Environmental Protection 2 Q.H.
(formerly 01.985)**Spring Quarter**

Environmental quality and its effects on health, comfort, aesthetics, balance of ecosystems and renewable resources; interaction of the water-land-air complex, vector control, food protection, ionizing radiation, other radiation, and the energies of heat and sound. *Prereq.: Admission to Graduate School of Engineering.*

CIV 3384 Solid Waste Management 2 Q.H.
(formerly 01.945)**Fall Quarter**

Basic solid waste management for engineering and science students covering storage, collection practices, sanitary landfill principles, incineration practices

and reclamation possibilities. *Prereq.: Admission to Graduate School of Engineering.*

CIV 3386 Hazardous Waste Practices 2 Q.H.
(formerly 01.946)**Spring Quarter**

An investigation of hazardous waste management practices including: identification, storage, transport, treatment processes, incineration, recycling, reuse, chemical landfills and groundwater contamination. *Prereq.: CIV 3311 or CIV 3312.*

CIV 3388 Design of Environmental Systems I 2 Q.H.
(formerly 01.971)**Winter Quarter**

Examination of analysis and design of environmental control systems using computer-based models as a tool. Development of components of a treatment system model applicable to simulate process using accepted mathematical relationships. Optimization of various combinations of systems on the basis of economics and/or performance. Development of sensitivity tests for fluctuation in such items as labor or power units costs. *Prereq.: CIV 3317 and general knowledge of a computer language (BASIC or FORTRAN).*

CIV 3389 Design of Environmental Systems II 2 Q.H.
(formerly 01.972)**Spring Quarter**

Fundamental design concepts of complete systems for environmental control, including water treatment; wastewater disposal, air quality control, and solid waste disposal; evaluation of economic alternatives for environmental quality control; discussion of actual engineering reports and designs will include considerations of the logic and conclusions. *Prereq.: CIV 3388.*

CIV 3392 Seminar-Environmental Engineering 2 Q.H.
(formerly 01.994)**Fall Quarter**

Discussion by professional engineers and scientists, faculty, and graduate students on subjects in the area of environmental engineering and science. Open to all students actively working on either a Master's Report or Thesis. *Prereq.: Consent of the instructor.*

CIV 3410 Soil Mechanics I 2 Q.H.
(formerly 01.871)**Fall Quarter**

Phase relationships and index properties, permeability, capillarity, effective stress concept, porous media flow, stress distribution, stress path concept, 1-D settlement analysis. *Prereq.: Undergraduate course in soil mechanics.*

CIV 3411 Soil Mechanics II 2 Q.H.
(formerly 01.872)**Winter Quarter**

Continuation of CIV 3410. Consolidation theory, 3-D settlement analysis, shear strength properties of soils, stress path analysis. *Prereq.: CIV 3410.*

CIV 3412 Soil Mechanics III 2 Q.H.
(formerly 01.873)**Spring Quarter**

Continuation of CIV 3411. Stability of open cuts and natural slopes; numerical analysis and computer applications to stability, seepage, consolidation, and deformation problems, laboratory testing; field instrumentation; special topics. *Prereq.: CIV 3411 or CIV 3413.*

CIV 3413 Soil Mechanics I and II 4 Q.H.
(formerly 01.877)**Fall Quarter**

Embodies the material in CIV 3410 and CIV 3411. *Prereq.: Undergraduate course in soil mechanics.*

CIV 3420 Foundation Engineering I 2 Q.H.
(formerly 01.874)**Fall Quarter, Alternate Years**

Lateral earth pressure theory; retaining wall design; anchored bulkheads; braced cofferdams, dewatering, observational approach to design. *Prereq.: CIV 3411.*

CIV 3421 Foundation Engineering II 2 Q.H.
(formerly 01.875)**Winter Quarter, Alternate Years**

Bearing capacity, design of shallow foundations, site improvement (preloading, deep densification), case studies of foundation performance. *Prereq.: CIV 3420.*

CIV 3422 Foundation Engineering III 2 Q.H.
(formerly 01.876)**Spring Quarter, Alternate Years**

Pile foundations, caissons, selection of foundation scheme; case studies. *Prereq.: CIV 3421.*

CIV 3423 Foundation Engineering I and II 4 Q.H.
(formerly 01.878)**Spring Quarter**

Embodies the course content offered in CIV 3420 and CIV 3421. *Prereq.: CIV 3411 or CIV 3413.*

CIV 3430 Soil-Structure Interaction 4QH
(formerly 01.870) Winter Quarter

Introduction to pile foundations; beam on elastic foundations; deformations of axially and laterally loaded single piles and pile groups using available computer software; pile load tests; case histories. *Prereq.: CIV 3411 or CIV 3413.*

CIV 3440 Experimental Soil Mechanics 4 Q.H.
(formerly 01.879)**Spring Quarter**

Laboratory evaluation of engineering properties of soils with emphasis on permeability, compressibility and strength. Introduction to model analysis of static and dynamic behavior of soils. *Prereq.: CIV 3411 or CIV 3413.*

CIV 3450 Engineering Geology 2 Q.H.
(formerly 01.882)**Fall Quarter, Alternate Years**

Review of minerals, selected topics in historical and structural geology related to engineering geology; origin and occurrence of various rock types, geologic structures, faulting and joint systems; weath-

ering of rock and weathering products, glaciation, geologic mapping and environmental aspects. *Prereq.: Undergraduate course in geology.*

CIV 3460 Rock Mechanics I 2 Q.H.
(formerly 01.884)**Winter Quarter, Alternate Years**

Interrelationship with other disciplines; index properties; classification systems; laboratory tests; state of stress and stress distribution. *Prereq.: CIV 3450.*

CIV 3461 Rock Mechanics II 2 Q.H.
(formerly 01.885)**Spring Quarter, Alternate Years**

Behavior of rock under combined stresses; pore pressure effects; failure theories; in-situ deformation modulus and shear strength characteristics; field testing. *Prereq.: CIV 3460.*

CIV 3470 Soil Dynamics I 2 Q.H.
(formerly 01.886)**Fall Quarter**

Dynamic response analysis of one-degree-of-freedom systems, characteristics of earthquakes and resulting ground motions, response spectra, stress-strain behavior of soils during dynamic and repeated loading, laboratory and field determinations, wave propagation through elastic media, effect of local soil condition upon earthquake ground motions. *Prereq.: Admission to the Geotechnical Engineering Program.*

CIV 3471 Soil Dynamics II 2 Q.H.
(formerly 01.887)**Winter Quarter**

Dynamic response analysis of a single mass, multi-degree-of-freedom systems; machine foundation design and analysis; soil-structure interaction, ground vibrations, sources and control; shear strength during repeated loading, liquefaction; dynamic analysis of retaining structures and slopes. *Prereq.: CIV 3470.*

CIV 3480 Seismic Design 2 Q.H.
(formerly 01.850)**Spring Quarter**

Earthquake considerations in building design process, dynamic analysis of multidegree-of-freedom elastic systems subjected to earthquake motions and cyclically applied forces, inelastic dynamic response analysis. Seismic provisions of building codes; soil-structure interaction. *Prereq.: CIV 3470.*

CIV 3485 Selected Topics in Earthquake 2 Q.H.
Engineering (formerly 01.851)**Spring Quarter**

Seismic hazard and seismic risk analysis; seismic design decision analysis; lifeline earthquake engineering; pipelines, liquid storage tanks, water distribution systems; earthquake analysis of earth dams and slopes; dynamic analysis of retaining walls and offshore facilities; dynamically loaded piles. *Prereq.: CIV 3470.*

CIV 3510 Advanced Structural 2 Q.H.
Mechanics I (formerly 01.841)**Fall Quarter**

Analysis of force equilibrium (stress), deformation displacement (strain), and forcedeformation (Hooke's

Law) for an elastic solid; compatibility; governing equations for complete and approximate elasticity solution. Plane stress solution for narrow rectangular beams. Torsion, Saint Venant's theory, membrane analogy, rectangular sections, thin open and closed sections. Introduction to bending of thin plates. *Prereq.: Undergraduate structural mechanics and structural analysis.*

CIV 3511 Advanced Structural Mechanics II (formerly 01.842) 2 Q.H.

Winter Quarter

Consistent models for the mechanics of simple structural elements: axial, bending, plane stress, and the like. Equilibrium, geometry of deformation, and force/deformation as the governing relations of all structural elements. Work and energy principles: virtual displacement, virtual forces, minimum potential energy, minimum complementary energy, introduction to variational ideas, Rayleigh-Ritz method. *Prereq.: CIV 3510.*

CIV 3512 Advanced Structural Mechanics I and II (formerly 01.847) 4 Q.H.

Fall Quarter

This course embodies the material in CIV 3510 and CIV 3511. However, more emphasis will be placed on variational principles. *Prereq.: Undergraduate structural mechanics and structural analysis.*

CIV 3520 Engineering Materials I (formerly 01.824) 2 Q.H.

Winter Quarter

Mechanical, microstructural, physical and chemical properties of cements and concretes and their roles in structures, pavements, bridge decks, repair and rehabilitation will be covered. Different concretes such as expansive cement concrete, sulfate-resistant concrete, sulfur concrete and fiber-reinforced concrete will be introduced. *Prereq.: Admission to Graduate School.*

CIV 3521 Engineering Materials II (formerly 01.825) 2 Q.H.

Spring Quarter

Topics include the elastic, plastic and viscoelastic properties of solids and composites; introduction to fracture mechanics and fatigue. *Prereq.: Admission to Graduate School.*

CIV 3525 Stability (formerly 01.859) 2 Q.H.

Spring Quarter

Prediction of the buckling loads in columns, behavior of beam columns, use of numerical methods to compute the buckling loads of nonprismatic members, buckling of plates. *Prereq.: CIV 3510 and CIV 3511.*

CIV 3530 Finite-Element Analysis of Structures I (formerly 01.843) 2 Q.H.

Spring Quarter

Introduction to finite-element method for structural analysis. Overview of direct stiffness method. Formulation of element stiffness matrices by direct use of elasticity relations and by energy methods for simple elements; axial, bending, plane stress, and

plane strain; transformation of coordinate systems; lumping work equivalent loads; bounds on the error solution. Plate bending. Use of finite-element computer programs. *Prereq.: CIV 3511.*

CIV 3531 Finite-Element Analysis of Structures II (formerly 01.844) 2 Q.H.

Fall Quarter

Additional applications of the finite-element method. *Prereq.: CIV 3530.*

CIV 3532 Finite-Element Analysis of Structures I and II (formerly 01.856) 4 Q.H.

Winter Quarter

Embodies the course content offered in CIV 3530 and CIV 3531. *Prereq.: CIV 3512 or CIV 3511.*

CIV 3535 Advanced Structural Analysis (formerly 01.845) 4 Q.H.

Fall Quarter

Offered days. Formulation and solution of structural problems with primary application to member systems (trusses, frames, curved members), matrix formulation of flexibility and stiffness methods: geometrically nonlinear behavior. *Prereq.: Admission to the Graduate School of Engineering.*

CIV 3540 Optimization in Structural Engineering (formerly 01.852) 4 Q.H.

Spring Quarter

Unconstrained and constrained optimization; Kuhn-Tucker condition: Sequential Unconstrained Minimization Technique (SUMT); design sensitivity analysis; Gradient Projection Method (GRP). Although problem formulation is quite general, emphasis will be on the practical structural application where the displacement (stiffness) method is used as part of the structural-synthesis algorithm. Knowledge of FORTRAN assumed. *Prereq.: CIV 3535.*

CIV 3545 Structural Dynamics (formerly 01.857) 4 Q.H.

Fall Quarter

Single degree of freedom structural systems, free vibration, forced vibration, Duhamel integral, time step integration, multidegree-of-freedom structural systems, model analysis, damping, response spectra, nonlinear systems, earthquake ground motions. *Prereq.: concurrently with CIV 3535.*

CIV 3550 Numerical Methods in Engineering Analysis (formerly 01.890) 4 Q.H.

Winter Quarter

Finite elements and finite differences methods for analysis of linear and nonlinear problems in solid, structural, and fluid mechanics. Computer-based numerical solutions in statics and dynamics (model analysis and direct integration). Eigensolution algorithms. Applications: forced vibration analysis, earthquakes, offshore, structural analysis. *Prereq.: CIV 3535 and CIV 3545.*

CIV 3560 Concrete Structures I 2 Q.H.
(formerly 01.853)**Fall Quarter**

Fundamentals of prestressing; design of prestressed concrete beams for flexure and shear; design of end blocks; load balancing method for the analysis of indeterminate prestressed structures; column design. *Prereq.: Undergraduate Reinforced Concrete Design and Structural Analysis.*

CIV 3561 Concrete Structures II 2 Q.H.
(formerly 01.854)**Winter Quarter**

Design of two-way slabs by the equivalent frame method; yield line theory; prestressing of slabs; the strip method; and introduction to folded plate design. *Prereq.: Undergraduate Reinforced Concrete Design and Structural Analysis.*

CIV 3562 Concrete Structures III 2 Q.H.
(formerly 01.855)**Spring Quarter**

Additional topics of folded plate design, design of thin shelled structures including hyperbolic paraboloids and shells of revolution. *Prereq.: CIV 3561.*

CIV 3570 Advanced Steel Design I 2 Q.H.
(formerly 01.861)**Fall Quarter**

An advanced course in elastic design in structural steel. Design problems involving braced and rigid frame structures subject to gravity, wind and seismic loads are considered. *Prereq.: Undergraduate Steel Design and Structural Analysis.*

CIV 3571 Advanced Steel Design II 2 Q.H.
(formerly 01.862)**Winter Quarter**

An advanced course in analysis and design in structural steel with emphasis on plastic behavior including rigid frame buildings and braced multistory frame buildings. *Prereq.: Undergraduate Steel Design and Structural Analysis.*

CIV 3572 Advanced Steel Design III 2 Q.H.
(formerly 01.863)**Spring Quarter**

Advanced problems in elastic and plastic design of structural steel. Topics include curved girders, cable supported structures, fatigue considerations, and composite sections with steel deck. *Prereq.: Undergraduate Steel Design and Structural Analysis.*

CIV 3580 Computer-Aided Structural Design (formerly 01.848) 4 Q.H.**Winter Quarter**

General characteristics of computer aided design software, development of software for the solution of typical structural steel and reinforced concrete design problems. *Prereq.: CIV 3535.*

CIV 3585 Marine Structures 4 Q.H.
(formerly 01.846)**Spring Quarter**

This course covers the behavior of marine structures from the materials and structural analysis/design

considerations. The first part covers the behaviors and properties of different materials in the marine environment. The second part covers the analysis/design aspects of these structures subjected to different environmental forces such as ice and ship impacts, wind and earthquakes. *Prereq.: CIV 3550 and CIV 3520.*

CIV 3610 Urban Public Transportation 2 Q.H.
(formerly 01.811)**Fall Quarter**

Analysis and planning of public transportation systems, including bus, subway, commuter rail, and paratransit; performance prediction; service evaluation and efficiency control measure; demand prediction; institutional and economic issues. *Prereq.: Admission to Graduate School.*

CIV 3620 Traffic Flow Theory I 2 Q.H.
(formerly 01.813)**Winter Quarter**

Statistical methods in traffic flow theory, probability models, hypothesis testing and its use, queuing theory, and simulation techniques. *Prereq.: Appropriate courses in calculus and statistics and permission of instructor.*

CIV 3621 Traffic Flow Theory II 2 Q.H.
(formerly 01.814)**Spring Quarter**

Continuation of CIV 3620. Deterministic methods in traffic flow theory, car following models, various methods of determination of capacity and level of service, computer applications. *Prereq.: CIV 3620.*

CIV 3630 Traffic Engineering 2 Q.H.
(formerly 01.817)**Spring Quarter**

Measurement of traffic characteristics and system performance; theory of traffic flow and analytical techniques; systems hardware design and evaluation; current concerns of energy, environmental, and urban amenity impacts; computer applications and institutional characteristics. *Prereq.: Admission to Graduate School.*

CIV 3635 Transportation Engineering 2 Q.H.
(formerly 01.820)**Winter Quarter**

Description and evaluation of different modes of transportation existing and proposed; their performance and cost characteristics; design, performance, and selection criteria for vehicles and roadbeds. *Prereq.: Admission to Graduate School.*

CIV 3640 Theory and Practice of Transportation Planning I (formerly 01.835) 2 Q.H.**Fall Quarter**

Establishments of goals, objectives and criteria; the current planning framework; examination of performance characteristics of transportation systems, including public and private modes on land, water, and airways. *Prereq.: Admission to Graduate School.*

CIV 3641 Theory and Practice of Transportation Planning II (formerly 01.836) 2 Q.H.
Fall Quarter

Continuation of CIV 3640. Transportation demand modeling from regional economic analysis to traffic and public transportation network assignment; technical and economic evaluation; current issues, including environmental assessment, transportation systems management, citizen participation, and planning in developing countries. *Prereq.: CIV 3640 to be taken previously or concurrently.*

CIV 3650 Urban Transportation Analysis I (formerly 01.815) 2 Q.H.
Winter Quarter

Principles of analysis of urban transportation systems including travel demand equilibrium, performance and evaluation techniques using aggregate and disaggregate methods. *Prereq.: CIV 3641 and appropriate graduate statistics courses.*

CIV 3651 Urban Transportation Analysis II (formerly 01.816) 2 Q.H.
Spring Quarter

Continuation of CIV 3650. Conceptualization, formulation, application, and evaluation of mathematical models utilized in urban transportation systems analysis; case studies of representative analyses. The objective of this course is to help prepare students to conceptualize, formulate, apply and evaluate appropriate mathematical modeling techniques in transportation. *Prereq.: CIV 3650.*

CIV 3798 Master's Thesis Continuation (formerly 01.9X1) 0 Q.H.
Any Quarter

CIV 3799 PhD Continuation (formerly 01.9X4) 0 Q.H.
Any Quarter

CIV 3830 Special Topic in Civil Engineering (formerly 01.992) 2 Q.H.
Fall, Winter, Spring Quarter

Topics of interest to the staff member conducting this course are presented for advanced study. The

course is initiated by the appropriate discipline committee and approved by the department. *Prereq.: Consent of the instructor.*

CIV 3835 Special Project in Civil Engineering (formerly 01.995) 2 Q.H.
Any Quarter

An individual effort in an area selected by student and adviser and approved by the Departmental Discipline Committee resulting in a definitive report. *Prereq.: Permission of the department.*

CIV 3850 Master's Report (formerly 01.993) 4 Q.H.
Any Quarter

An individual effort consisting of laboratory and/or literature investigation and analysis or advanced design of a project in an area of civil engineering selected by student and adviser resulting in a definitive report. *Prereq.: Permission of the Civil Engineering Department.*

CIV 3851 Master's Report 2 Q.H.
Any Quarter

CIV 3860 Master's Thesis (formerly 01.991) 8 Q.H.
Any Quarter

Analytical and/or experimental research conducted by arrangement with and under the supervision of the department. *Prereq.: Permission of the Civil Engineering Department.*

CIV 3861 Master's Thesis 4 Q.H.
Any Quarter

CIV 3862 Master's Thesis 2 Q.H.
Any Quarter

CIV 3870 PhD Thesis (formerly 01.997) 2 Q.H.
Any Quarter

Open to full-time doctoral students only. *Prereq.: Admission to doctoral program in Civil Engineering.*

Interdisciplinary Transportation

OINT 3798 Master's Thesis Continuation 0 Q.H.
Any Quarter

OINT 3835 Special Project in Transportation (formerly 93.818) 2 Q.H.
Any Quarter

An individual effort in an area selected by student and adviser resulting in a definite report. *Prereq.: Permission of the Civil Engineering Department.*

OINT 3850 Master's Report in Transportation (formerly 93.819) 4 Q.H.
Any Quarter

An individual effort consisting of laboratory and/or literature investigation and analysis or advanced de-

sign of a project in an area of transportation selected by student and adviser resulting in a definitive report. *Prereq.: Permission of the Civil Engineering Department.*

OINT 3860 Master's Thesis in Transportation (formerly 93.820) 8 Q.H.
Any Quarter

Analytical and/or experimental work conducted by arrangement with and under the supervision of the department. *Prereq.: Permission of the Civil Engineering Department.*

Electrical and Computer Engineering

Each course description includes information on the expected quarter in which classes are usually offered. The quarters listed are presented here for planning purposes; however, the Graduate School of Engineering cannot guarantee that all courses will be offered. Students must refer to the Graduate School of Engineering Quarterly Course Offering sheets to determine what courses are actually offered in any given quarter and at what day and time.

ECE 3100 Introduction to Circuits and Systems (formerly 03.846) 4 Q.H.

Fall Quarter

The circuit elements (R, L and C) are introduced. Kirchhoff's laws, Tellegen and Thevenin's theorem. Mesh and nodal analysis. Development of system function approach, Laplace and Fourier transform theory applied to circuit analysis. Sinusoidal steady-state, n-port network theory, and power and energy concepts. *Prereq.: Admission to Graduate School*

ECE 3101 Introduction to Electronics (formerly 03.847) 4 Q.H.

Winter Quarter

Characteristics of the theoretical physical junction. The Ebers-Moll model for bipolar junction transistors, characteristics of bipolar and field-effect devices, basic digital inverters and logic gates and various logic families. Use of transistors in the design of analog circuits. Biasing, linearized incremental models, load lines, signal flowgraphs, frequency response and gain calculation for single and cascaded stages. *Prereq.: ECE 3100 or equivalent.*

ECE 3102 Introduction to Electromagnetic Field Theory (formerly 03.848) 4 Q.H.

Spring Quarter

Definition of scalar and vector fields; vector calculus; concepts of gradient, divergence, curl and the "del" operator; free-space electrostatics; the generalization of the Maxwell equations to the case of time-varying fields; Faraday induction law, wave equations and the plane wave solution. *Prereq.: ECE 3100 or equivalent.*

ECE 3103 Introduction to Digital Computers (formerly 03.849) 4 Q.H.

Fall Quarter

Basic components of digital systems and methods for their analysis and design, combinational and sequential circuits, integrated circuit logic families and functional building blocks, registers, counters, decoders, multiplexers and memories. Data representation and coding techniques. Central processor alternatives; instruction formats, addressing modes, bus structures, arithmetic units, timing analysis and stacks. Algorithms for arithmetic operations with various data representations. *Prereq.: Admission to Graduate School.*

ECE 3104 Introduction to Communications (formerly 03.850) 4 Q.H.

Spring Quarter

Review of system theory, convolution, Fourier series, Fourier integral, signal analysis, Fourier methods, correlation functions, density functions, power spectra, amplitude modulation, frequency modulation,

phase modulation, sampling theory and digital modulation techniques. *Prereq.: ECE 3108 or equivalent.*

ECE 3105 Introduction to System Software I 2 Q.H.

Fall Quarter

A knowledge of PASCAL is helpful but not required for this course. Programming style considerations, software testing and software reliability. Data structures, including stacks, queues, linked lists, trees and graphs. The course emphasizes the use of PASCAL to implement typical system software routines that use the above data structures. Miscellaneous topics also discussed are modern system software considerations for multiprocessor, array processor and graphic processor systems. *Prereq.: Admission to Graduate School.*

ECE 3106 Introduction to Systems Software II 2 Q.H.

Winter Quarter

An analysis of absolute and relocatable program translators. The topics covered are assemblers, disassemblers, macroassemblers, linkers, an overview of compilers, interpreters, simulators and emulators. For a typical lab assignment, the student will design and implement an absolute assembler for a very simplified instruction set. *Prereq.: ECE 3105.*

ECE 3107 Introduction to System Software III 2 Q.H.

Spring Quarter

An analysis of operating system structure and concepts. Memory management, fragmentation, paging, virtual memory, job and process scheduling, I/O management, file management. Operating system concepts for multiuser systems. Critical variables, race conditions, Dekker's algorithm, some sample multiuser routines. For a typical lab assignment, the student will write simulated paged memory management and process scheduling routines. *Prereq.: ECE 3106.*

ECE 3108 Introduction to Signals and Systems 4 Q.H.

Winter Quarter

Description and analysis of continuous and discrete signals and systems. Properties of systems. The input-output relationship of linear time-invariant systems. Discrete and continuous Fourier series and Fourier transforms. Laplace and z-transforms. Elements of filtering and sampling. *Prereq.: ECE 3100 or equivalent.*

ECE 3120 Power Circuit Analysis I 2 Q.H.
(formerly 03.925)**Fall Quarter**

Fundamental concepts of single-phase and poly-phase power systems; definitions of terms; use of per unit quantities; equivalent circuits of symmetrical 3-phase systems; introduction of symmetrical components; short circuits on systems with a single power source. *Prereq.: BSEE or ECE 3100 and ECE 3102.*

ECE 3130 Electrical Machinery Theory I 2 Q.H.
(formerly 03.940)**Fall Quarter**

Review of magnetic circuit concepts and electro-mechanical energy-conversion principles; steady-state analysis of transformers, synchronous machines, and induction machines. *Prereq.: BSEE or ECE 3100 and ECE 3102.*

ECE 3200 Mathematical Methods in Computer Science (formerly 03.8A1) 2 Q.H.**Fall Quarter**

Algebraic concepts relevant to computer science; sets, relations, mapping, orderings, algebraic systems, Boolean algebras, groups, rings, finite fields, introduction to vector spaces and linear algebras over finite fields. *Prereq.: Admission to Graduate School.*

ECE 3211 Mathematical Methods in Electrical Engineering I (formerly 03.823) 4 Q.H.**Fall and Winter Quarters**

Linear algebraic equations; Gauss algorithm; linear operators in an n-dimensional vector space over infinite and finite fields; characteristic value problem, minimal polynomial; functions of a matrix; equivalence, congruence, and similarity transformation, canonical forms; polynomial matrices; Smith normal form; determinantal divisors; invariant polynomials, elementary divisors; companion and Jordan canonical matrices; decomposition of a vector space into invariant subspaces with respect to a linear operator. *Prereq.: Admission to Graduate School.*

ECE 3212 Mathematical Methods in Electrical Engineering I-A 2 Q.H.**Fall and Winter Quarters**

ECE 3212 and ECE 3213 cover the same material with the same prerequisites as ECE 3211, but in two 2QH courses.

ECE 3213 Mathematical Methods in Electrical Engineering I-B 2 Q.H.**Winter and Spring Quarters**

Continuation of ECE 3212. *Prereq.: ECE 3212.*

ECE 3221 Linear Systems Analysis 4 Q.H.
(formerly 03.827)**Fall and Winter Quarters**

Introduction to the state variable theory of continuous and discrete linear systems. Standard canonical representations. The concept of state and the representation of interconnected systems. Linear spaces. The state equations and their solution. Stability. In-

troduction to the general control problem in terms of controllability and observability. *Prereq.: ECE 3211, ECE 3108 or equivalent.*

ECE 3222 Linear Systems Analysis A 2 Q.H.
(formerly 03.825)**Fall and Winter Quarters**

ECE 3222 and ECE 3223 cover the same material with the same prerequisites as ECE 3221, but in two 2QH courses.

ECE 3223 Linear Systems Analysis B 2 Q.H.
(formerly 03.826)**Winter and Spring Quarters**

Continuation of ECE 3222. *Prereq.: ECE 3222.*

ECE 3231 Mathematical Methods in Electrical Engineering II 4 Q.H.**Summer Quarter**

Complex variable theory; mapping by functions, definite and indefinite integrals, Cauchy integral formula, Laurent series, the residue theorem and branch points. Application of complex variable theory to Fourier theory, Hilbert transforms, and conformal transformations in the analysis of linear systems and in electrostatics; the Schwarz-Christoffel transformation, Poisson's integral formula and concept of analytical continuation. *Prereq.: Admission to Graduate School.*

ECE 3232 Mathematical Methods in Electrical Engineering II-A (formerly 03.8C1) 2 Q.H.**Summer Quarter**

ECE 3232 and ECE 3233 cover the same material with the same prerequisites as ECE 3231, but in two 2QH courses.

ECE 3233 Mathematical Methods in Electrical Engineering II-B (formerly 03.8C2) 2 Q.H.**Summer Quarter**

Continuation of ECE 3232. *Prereq.: ECE 3232*

ECE 3241 Applied Probability and Stochastic Processes (formerly 03.902) 4 Q.H.**Fall and Winter Quarters**

Introductory probability, sample space and random variables, examples of discrete and continuous probability distribution functions, averages, moments and characteristic function, multivariate distributions, change of variables and functions of variables, central limit theorem, description of stochastic vectors. General concepts of stochastic processes, stationarity and ergodicity, stochastic continuity and differentiation, the Gaussian process, linear systems with stochastic inputs, correlation functions and power spectra, matched filtering, stochastic orthogonality and linear mean-square estimation filtering and prediction. *Prereq.: ECE 3108 or equivalent.*

ECE 3242 Applied Probability and Stochastic Processes A (formerly 03.900) 2 Q.H.**Fall and Winter Quarters**

ECE 3242 and ECE 3243 cover the same material with the same prerequisites as ECE 3241, but in two 2QH courses.

ECE 3243 Applied Probability and Stochastic Processes B (formerly 03.901) 2 Q.H.
Winter and Spring Quarters
 Continuation of ECE 3242. *Prereq.: ECE 3242.*

ECE 3302 Power Circuit Analysis II (formerly 03.926) 2 Q.H.
Winter Quarter

This course is a continuation of ECE 3120 Power Circuit Analysis I. Sequence impedances of various power-system elements are considered from an application point of view; unsymmetrical faults on otherwise symmetrical 3-phase systems; open conductors and asymmetrical connections and loadings; analysis of simultaneous faults on 3-phase systems. *Prereq.: ECE 3120.*

ECE 3303 Power Circuit Analysis III (formerly 03.927) 2 Q.H.
Spring Quarter

This course is a continuation of ECE 3302, Power Circuit Analysis II. Introduction of Clarke components and applications in analysis of asymmetrical systems and faults; application of Clarke components to the solution of surge phenomena problems; transmission line theory; fundamentals of systems stability. *Prereq.: ECE 3302.*

ECE 3304 Solid State AC and DC Motor Control Systems (formerly 03.929) 2 Q.H.
Winter Quarter

The application of solid-state devices to the control of AC and DC electrical machinery, including rectifiers, inverters, choppers and cyclo-converters, as applied to drive systems in industry and transportation. The course will emphasize a case method approach. *Prereq.: BSEE or ECE 3100 and ECE 3101.*

ECE 3305 Computers in Power Systems I (formerly 03.935) 2 Q.H.
Fall Quarter

Techniques used in solving power system problems with the digital computer. Matrix formulations are examined, followed by a detailed treatment of the short-circuit problem, including balanced and unbalanced faults. Various iterative techniques are studied for the solution of the power-flow problem. *Prereq.: BSEE or ECE 3120.*

ECE 3306 Computers in Power Systems II (formerly 03.936) 2 Q.H.
Winter Quarter

Practical considerations of solving large scale networks are discussed. Network reductions, distribution factors and contingency analysis techniques are developed. Digital models for regulated generators, fixed and load tap changing transformers and HVDC transmission lines are examined. Computer methods for economic dispatch, loss coefficients and application of pumped hydro are developed. *Prereq.: ECE 3305.*

ECE 3308 Electrical Machinery Theory II (formerly 03.941) 2 Q.H.
Winter Quarter

Mathematical description of a synchronous machine; per-unit representation; steady-state theory and transient performance; flux distribution and saturation in synchronous machines. *Prereq.: ECE 3130.*

ECE 3309 Electrical Machinery Theory III (formerly 03.942) 2 Q.H.
Spring Quarter

Review of transient behavior of synchronous machines; stability studies and excitation systems; synchronous machine modeling; generator protection; trends in development of large generators. *Prereq.: ECE 3308.*

ECE 3311 Software Engineering I (formerly 03.896) 4 Q.H.
Fall Quarter

An introduction to basic concepts in software engineering principles is given. Techniques of structured software design and testing are discussed along with issues of program reliability and complexity. Management techniques are touched upon and a case study of a typical large software problem is undertaken. *Prereq.: ECE 3105, 3106, 3107 or equivalent, and a knowledge of a high-level programming language.*

ECE 3312 Software Engineering I-A (formerly 03.893) 2 Q.H.
Fall and Winter Quarters

ECE 3312 and ECE 3313 cover the same material with the same prerequisites as ECE 3311, but in two 2QH courses.

ECE 3313 Software Engineering I-B (formerly 03.894) 2 Q.H.
Winter and Spring Quarters

Continuation of ECE 3312. *Prereq.: ECE 3312.*

ECE 3314 Software Engineering II (formerly 03.895) 2 Q.H.
Spring Quarter

Focus turns away from the general issues of the first two courses in this sequence and toward a very specific issue, modular design of software. Issues of stepwise refinement and top-down design are explored in depth, and organizational/data-flow issues are considered. *Prereq.: ECE 3311.*

ECE 3321 Digital Signal Processing (formerly 03.879) 4 Q.H.
Winter Quarter

Theory and practice of modern signal processing techniques. Characteristics of discrete signals and systems; sampling and A/D conversion; difference equations; convolution; the z-transform, the Fourier transform and the discrete Fourier transform; fast Fourier transform algorithms; chirp z-transform algorithm; digital filter realizations; design techniques for IIR and FIR digital filters; computer programs for filter design; quantization effects in digital signal processing. *Prereq.: ECE 3221.*

ECE 3322 Digital Signal Processing A 2 Q.H.
(formerly 03.877)**Fall and Winter Quarters**

ECE 3322 and ECE 3323 cover the same material with the same prerequisites as ECE 3321, but in two 2QH courses.

ECE 3323 Digital Signal Processing B 2 Q.H.
(formerly 03.878)**Winter and Spring Quarters**

Continuation of ECE 3322. *Prereq.: ECE 3322.*

ECE 3325 Numerical Methods and Computer Applications I (formerly 03.8T0) 4 Q.H.**Winter Quarter**

Survey of numerical methods applied to engineering and scientific problems with emphasis on machine implementation and problem solving; roundoff errors and cumulative errors; difference and summation calculus; roots of polynomials and nonlinear functions; orthogonal functions including polynomial, least squares, and Chebyshev approximation of functions; systems of algebraic equations, matrix notation, and machine implementation; inversion of matrices including iterative methods; sparse matrix techniques. Interpolation; numeric quadrature; numeric integration of ordinary differential equations including predictor-corrector methods; stiff dynamic equations, partial differential equations, approximations, boundary value problems. *Prereq.: Admission to Graduate School and a working knowledge of FORTRAN.*

ECE 3326 Numerical Methods and Computer Applications I-A (formerly 03.8T1) 2 Q.H.**Fall and Winter Quarters**

ECE 3326 and ECE 3327 cover the same material with the same prerequisites as ECE 3325, but in two 2QH courses.

ECE 3327 Numerical Methods and Computers Applications I-B (formerly 03.8T2) 2 Q.H.**Winter and Spring Quarters**

Continuation of ECE 3326. *Prereq.: ECE 3326.*

ECE 3328 Numerical Methods and Computer Applications II (formerly 03.8T3) 4 Q.H.**Spring Quarter**

Spectral analysis, including fast Fourier transforms, Hilbert transforms, convolution, and correlation techniques. Optimization, including dynamic programming and steepest descent techniques. PERT and linear programming. Other selected topics. *Prereq.: ECE 3325 or ECE 3327.*

ECE 3331 Linear Active Circuits 4 Q.H.
(formerly 03.842)**Winter Quarter**

Active compound circuits with emphasis on IC circuit topologies are developed as an extension of known discrete active device characteristics. Use is made of modern circuit theory techniques, including flowgraphs, matrices, Blackman's formulation for feedback and frequency response in terms of natural frequencies to determine compound circuit limita-

tions. Models of IC operational amplifiers, instrumentation amplifiers, voltage comparators, and the like are developed and analyzed. Advantages and limitations of these IC active circuits are investigated. IC operational amplifiers, advantages and limitations including dynamic range, overload characteristics, and slow rate. Gain-bandwidth and speed characteristics are investigated for large and small signal conditions. Feedback, stability, and compensation in closed-loop systems and effects of feedback on impedance levels are explored. Applications for analog signal processing and conditioning, i.e., active filter design, summing, integration and coefficient amplifiers are investigated. Limitations caused by shot and thermal noise, definition of noise figure, and noise models are taken up. *Prereq.: ECE 3101 or equivalent.*

ECE 3332 Linear Active Circuits A 2 Q.H.
(formerly 03.840)**Fall Quarter**

ECE 3332 and ECE 3333 cover the same material with the same prerequisites as ECE 3331, but in two 2QH courses.

ECE 3333 Linear Active Circuits B 2 Q.H.
(formerly 03.841)**Winter Quarter**

Continuation of ECE 3332. *Prereq.: ECE 3332.*

ECE 3341 Electromagnetic Theory 4 Q.H.
(formerly 03.877)**Fall Quarter**

Maxwell's equations and related electromagnetic laws and relations; basic properties of matter; electromagnetic potentials; the scalar and vector Poisson, D'Alembert, and Helmholtz equations; Green's functions; both mathematical and physical aspects of the theory and their relation to engineering applications. Basic radiation phenomenon including retarded potentials, radiation from moving charges, electromagnetic energy, and energy-related theorems. *Prereq.: ECE 3102 or equivalent.*

ECE 3342 Electromagnetic Theory A 2 Q.H.
(formerly 03.875)**Fall Quarter**

ECE 3342 and ECE 3343 cover the same material with the same prerequisites as ECE 3341, but in two 2QH courses.

ECE 3343 Electromagnetic Theory B 2 Q.H.
(formerly 03.876)**Winter Quarter**

Continuation of ECE 3342. *Prereq.: ECE 3342.*

ECE 3344 Advanced Electromagnetic Theory (formerly 03.87G) 4 Q.H.**Winter Quarter**

More advanced topics in electromagnetic theory including: waveguides, antennas, diffraction, and scattering; approximation techniques for obtaining useful solutions of field theory problems including integral equation, perturbation, and variational techniques. Special relativity and relativistic electrodynamics.

Radiation from moving charges. Statistical concepts and propagation in random media. *Prereq.: ECE 3341.*

ECE 3345 Advanced Electromagnetic Theory A (formerly 03.878) 2 Q.H.

Winter Quarter

ECE 3345 and ECE 3346 cover the same material with the same prerequisites as ECE 3344, but in two 2QH courses.

ECE 3346 Advanced Electromagnetic Theory B (formerly 03.879) 2 Q.H.

Spring Quarter

Continuation of ECE 3345. *Prereq.: ECE 3345.*

ECE 3347 Computational Methods in Electromagnetics (formerly 03.8H7) 4 Q.H.

Spring Quarter

Modern numerical methods are presented for solving problems in transmission, radiation, and scattering of electromagnetic waves. Individual topics will be discussed from both the viewpoint of understanding the relevant theory and the associated numerical technique. Integral equations will be introduced along with solutions by the method of moments. Applications will be given related to wire structures. Classical scattering from two-dimensional structures will be considered from the viewpoint of basic functions and edge effects. Scattering from more general shapes will proceed from the geometrical theory of diffraction. As time permits, computational methods in inverse scattering, target recognition, and transient radiation problems will be considered. *Prereq.: ECE 3341.*

ECE 3348 Computational Methods in Electromagnetics A (formerly 03.8H5) 2 Q.H.

Fall Quarter

ECE 3348 and ECE 3349 cover the same material with the same prerequisites as ECE 3347, but in two 2QH courses.

ECE 3349 Computational Methods in Electromagnetics B (formerly 03.8H6) 2 Q.H.

Winter Quarter

Continuation of ECE 3348. *Prereq.: ECE 3348.*

ECE 3351 Digital Communications (formerly 03.9C3) 4 Q.H.

Winter Quarter

Deals with the theoretical and practical aspects of digital communications in the presence of channel distortion and additive noise. Topics covered include the basic binary and M-ary modulation techniques, namely, PSK, PAM, FSK, orthogonal and biorthogonal signals, and their performance in an additive Gaussian noise channel; signal waveforms constructed from binary block and convolutional codes; hard-decision decoding and soft-decision decoding of coded signal waveforms; performance of coded waveforms in an additive white Gaussian noise channel. Signal design techniques for band-limited channels; Nyquist criteria; effect of channel amplitude and delay distortion on digital signals; discussion of several adaptive equalization algorithms for combating inter-

symbol interference; maximum likelihood sequence estimation and the Viterbi algorithm; the characterization of fading multipath channels; diversity reception techniques; coding for fading channels. *Prereq.: ECE 3241 and ECE 3104 or equivalent.*

ECE 3352 Digital Communications A (formerly 03.9C1) 2 Q.H.

Fall Quarter

ECE 3352 and ECE 3353 cover the same material with the same prerequisites as ECE 3351, but in two 2QH courses.

ECE 3353 Digital Communications B (formerly 03.9C2) 2 Q.H.

Winter Quarter

Continuation of ECE 3352. *Prereq.: ECE 3352.*

ECE 3361 Detection and Estimation Theory (formerly 03.909) 4 Q.H.

Winter Quarter

This course presents the classical theory of detection and estimation of signals in noise with emphasis on computer implementation of the theory. Particular topics include: hypothesis testing criteria; coherent detection of M-ary signals; diversity receiver; calculation of error probabilities. Detection in colored noise; parameter estimation using Bayes, maximum-likelihood, a maximum a posteriori criteria; applications in pattern recognition and radar. *Prereq.: ECE 3241.*

ECE 3362 Detection and Estimation Theory A (formerly 03.906) 2 Q.H.

Winter Quarter

ECE 3362 and ECE 3363 cover the same material with the same prerequisites as ECE 3361, but in two 2QH courses.

ECE 3363 Detection and Estimation Theory B (formerly 03.907) 2 Q.H.

Spring Quarter

Continuation of ECE 3362. *Prereq.: ECE 3362.*

ECE 3371 Linear Optimal Control Theory (formerly 03.9A8) 4 Q.H.

Spring Quarter

Introduction to linear optimal control systems. The optimal linear regulator and matrix ricatti equation, tracking problems, steady state and transient analysis, sensitivity, effects of uncertainty. Optimal linear state reconstruction, optimal linear output feedback, computer implementation of linear optimal control. *Prereq.: ECE 3221.*

ECE 3372 Linear Optimal Control Theory A (formerly 03.9A6) 2 Q.H.

Winter Quarter

ECE 3372 and ECE 3373 cover the same material with the same prerequisites as ECE 3371, but in two 2QH courses.

ECE 3373 Linear Optimal Control Theory B (formerly 03.9A7) 2 Q.H.

Spring Quarter

Continuation of ECE 3372. *Prereq.: ECE 3372.*

ECE 3381 Classical Control Theory 4 Q.H.
(formerly 03.959)**Fall Quarter**

Classical analysis techniques for continuous and sampled-data control systems. Discussion of stability criteria; application of root-locus and Bode methods for complementary time and frequency-domain analysis. Computer simulation of typical control systems will be emphasized. A review of cascade and feedback compensation techniques with the use of classical criteria for design of continuous and sampled-data control systems. Consideration of the multiple-input problem. A survey of pole-zero synthesis methods, and comparison with other techniques. Computer simulation of design examples. *Prereq.: ECE 3221.*

ECE 3382 Classical Control Theory A 2 Q.H.
(formerly 03.957)**Fall Quarter**

ECE 3382 and ECE 3383 cover the same material with the same prerequisites as ECE 3381, but in two 2QH courses.

ECE 3383 Classical Control Theory B 2 Q.H.
(formerly 03.958)**Winter Quarter**

Continuation of ECE 3382. *Prereq.: ECE 3382.*

ECE 3384 Characteristics and Models of 4 Q.H.
Solid State Devices I (formerly 03.8G0)**Winter Quarter**

This course is designed to develop insight into the operation of a broad range of semiconductor devices. Important topics in the physics of semiconductors to provide the background necessary for device analysis are discussed. Analysis of fundamental building-block units of which devices are made including PN junction, the Ohmic contact and the Schottky barrier. Each is examined under reasonable extremes of bias and temperature to establish the electrical behavior expected from such elementary units. Detailed analysis of bipolar transistor, metal-oxide-semiconductor interface, its influence on the behavior of real junctions, and the various realizations of the field-effect transistor. *Prereq.: BSEE or ECE 3101 and ECE 3102.*

ECE 3385 Characteristics and Models of 2 Q.H.
Solid State Devices I-A (formerly 03.8G1)**Fall Quarter**

ECE 3385 and ECE 3386 cover the same material with the same prerequisites as ECE 3384, but in two 2QH courses.

ECE 3386 Characteristics and Models of 2 Q.H.
Solid State Devices I-B (formerly 03.8G2)**Winter Quarter**

Continuation of ECE 3385. *Prereq.: ECE 3385.*

ECE 3387 Characteristics and Models of 2 Q.H.
Solid State Devices II (formerly 03.8G3)**Spring Quarter**

A detailed analysis of the performance of FETs will permit a critical comparison of field effect and bi-

polar transistors. Solid state microwave devices; devices that are both unique to microwave applications and the relevant low-frequency elements which require somewhat different analysis at microwave frequencies. An examination of noise in semiconductor devices. *Prereq.: ECE 3384.*

ECE 3391 Digital Computer Architecture 4 Q.H.
(formerly 03.979)**Fall Quarter**

This course is directed toward the design of a complete computer in register transfer language. Analysis and synthesis of combinational and sequential circuits. Organization and detailed logic design of an elementary digital computer. Other topics may include buss organization, interfacing with asynchronous peripherals, digital logic families, hardware/software tradeoffs, address modes, and memory hierarchies. *Prereq.: ECE 3103 or equivalent.*

ECE 3392 Digital Computer Architecture A 2 Q.H.
(formerly 03.972)**Fall and Winter Quarters**

ECE 3392 and ECE 3393 cover the same material with the same prerequisites as ECE 3391, but in two 2QH courses.

ECE 3393 Digital Computer Architecture B 2 Q.H.
(formerly 03.973)**Winter and Spring Quarters**

Continuation of ECE 3392. *Prereq.: ECE 3392*

ECE 3394 Microprogramming 2 Q.H.
(formerly 03.974)**Spring Quarter**

Topics in microprogramming and emulation including microprogramming concepts and techniques; microprogramming design approach using register transfer notation and precedence graphs; microprogrammed computers, bit-slice microprogramming, microprogramming a specific machine for emulation using a microprogramming language and its simulator; current trends in microprogramming languages and support tools. *Prereq.: ECE 3391*

ECE 3395 Elements of VLSI Design 4 Q.H.
(formerly 03.8E6)**Spring Quarter**

MOS devices and circuits, fabrication of integrated systems, design rules, subsystems design examples, implementation of integrated systems designs. *Prereq.: ECE 3331.*

ECE 3396 Elements of VLSI Design A 2 Q.H.
(formerly 03.8E4)**Fall Quarter**

ECE 3396 and ECE 3397 cover the same material with the same prerequisites as ECE 3395, but in two 2QH courses.

ECE 3397 Elements of VLSI Design B 2 Q.H.
(formerly 03.8E5)**Winter Quarter**

Continuation of ECE 3396. *Prereq.: ECE 3396.*

ECE 3412 Power System Planning 4 Q.H.
(formerly 03.931)**Spring Quarter**

Engineering and economic considerations underlying the planning and development of modern interconnected power systems. Consideration of overall planning strategies involved in economic comparison of alternative development schemes. *Prereq.: ECE 3120.*

ECE 3415 Power Systems Protection 2 Q.H.
(formerly 03.932)**Winter Quarter**

Consideration of protection applied to generation, transmission, and distribution. Investigation of the characteristics and operating principles of various methods of protective relaying; analysis of current techniques pertaining to system protection. *Prereq.: ECE 3303.*

ECE 3416 Power System Transients 2 Q.H.
(formerly 03.933)**Fall Quarter**

Transients in power systems due to system switching, lightning, or faults. Traveling-wave phenomena; insulation coordination; overvoltages due to disturbances on the system; surge protection. *Prereq.: ECE 3303.*

ECE 3423 Special Topics in Power 2 Q.H.
(formerly 03.944)**Spring Quarter**

Directed reading and discussion of topics of special interest in the power field. Series of lectures by guest speakers from industry on topics of particular interest to the power student. *Prereq.: Permission of Instructor.*

ECE 3424 Power System Dynamics 2 Q.H.
(formerly 03.945)**Spring Quarter**

Transient system models; small and large scale oscillations; solution of swing equation for single and multigenerator cases; load frequency and voltage controllers and transient stability. *Prereq.: ECE 3303.*

ECE 3430 Studies in Electric Power 2 Q.H.
Transmission II (formerly 03.955)**Fall Quarter**

Elements in the design of AC overhead transmission lines; thermal limitation, series and shunt compensation, environmental effects; consideration of transposition, induced effects, and insulation level. Underground alternatives to overhead lines. Elements of distribution. *Prereq.: ECE 3303.*

ECE 3431 Studies in Electric Power 2 Q.H.
Transmission II (formerly 03.956)**Winter Quarter**

Fundamental concepts of high voltage DC power transmission; rectifier and inverter performance; regulation; protection; reactive power and filter requirements; practical arrangement of DC lines; the impact of a DC line on overall power system operation. *Prereq.: ECE 3303.*

ECE 3440 Microprocessor-Based Design 4 Q.H.
(formerly 03.8F3)**Spring Quarter**

The role of the microcomputer in integrated/firmware/software/systems is explored. Techniques such as interfacing and regulation by microcomputer are examined, relative to both architectural and firmware requirements. Special purpose modular hardware is examined, and techniques of top-down modular software design are introduced. *Prereq.: ECE 3391.*

ECE 3441 Microprocessor-Based Design A 2 Q.H.
(formerly 03.8F1)**Fall Quarter**

ECE 3441 and ECE 3442 cover the same material with the same prerequisites as ECE 3440, but in two 2QH courses.

ECE 3442 Microprocessor-Based Design B 2 Q.H.
(formerly 03.8F2)**Winter Quarter**

Continuation of ECE 3441. *Prereq.: ECE 3441.*

ECE 3443 Theory of Computation 4 Q.H.
(formerly 03.8F0)**Spring Quarter**

This course deals with basic abstract models of computation. Topics include Turing machines, primitive recursive functions, recursive systems of equations and abstract families of algorithms. Unsolvability problems are examined, along with the Recursion Theorem. *Prereq.: ECE 3200.*

ECE 3444 Theory of Computation A 2 Q.H.
(formerly 03.985)**Fall Quarter**

ECE 3444 and ECE 3445 cover the same material with the same prerequisites as ECE 3443, but in two 2QH courses.

ECE 3445 Theory of Computation B 2 Q.H.
(formerly 03.986)**Winter Quarter**

Continuation of ECE 3444. *Prereq.: ECE 3444.*

ECE 3447 Switching Theory I 4 Q.H.
(formerly 03.966)**Spring Quarter**

Logical design of combinational switching circuits, including minimization and decomposition of switching functions; multiple output networks; symmetric networks; threshold logic, fault detection. Logic design of sequential switching circuits including finite-state machine model; iterative networks; capabilities and limitations of finite-state machines; state equivalence; synthesis of asynchronous sequential circuits; state assignment problem and partition theory; machine decomposition. Logical design of sequential switching circuits, including the finite-state machine model; iterative networks; capabilities and limitations of finite-state machines; state equivalence; synthesis of asynchronous sequential circuits; state assignment problem and partition theory; machine decomposition. *Prereq.: ECE 3200.*

ECE 3448 Switching Theory I-A 2 Q.H.
(formerly 03.967)**Fall Quarter**

ECE 3448 and ECE 3449 cover the same material with the same prerequisites as ECE 3447, but in two 2QH courses.

ECE 3449 Switching Theory I-B 2 Q.H.
(formerly 03.968)**Winter Quarter**

Continuation of ECE 3448. *Prereq.: ECE 3448.*

ECE 3450 Switching Theory II 2 Q.H.
(formerly 03.969)**Spring Quarter**

Selected topics from the theory of finite automata, including such topics as machine experiments; information lossless machines; linear sequential machines; finite-state recognizers. *Prereq.: ECE 3447.*

ECE 3451 Combinatorial Methods and Optimization Techniques 4 Q.H.
(formerly 03.888)**Winter Quarter**

An introductory course in applied combinatorial mathematics which treats selected topics in enumerative analysis. Particular subjects include permutations, combinations, generating functions, recurrence relations, and the principle of inclusion and exclusion. Polya's theory of counting; selected topics in optimization techniques, which include transport networks, matching theory, linear programming, and an introduction to dynamic programming. *Prereq.: ECE 3200.*

ECE 3452 Combinatorial Methods and Optimization Techniques A 2 Q.H.
(formerly 03.898)**Winter Quarter**

ECE 3452 and ECE 3453 cover the same material with the same prerequisites as ECE 3451, but in two 2QH courses.

ECE 3453 Combinatorial Methods and Optimization Techniques B 2 Q.H.
(formerly 03.899)**Spring Quarter**

Continuation of ECE 3452. *Prereq.: ECE 3452.*

ECE 3454 Graph Theory 2 Q.H.
(formerly 03.837)**Spring Quarter**

Fundamentals of graph theory, including blocks, trees, connectivity, partitions, traversability, line graphs, factorization, coverings, planarity, matrices, digraphs, and enumeration problems. Selected applications of graph theory in such fields as network theory, switching theory, and computer science. *Prereq.: ECE 3211.*

ECE 3460 Special Topics in Computer Engineering 2 Q.H.
(formerly 03.988)**Spring Quarter**

Aspects of computer engineering not covered in other courses. The subject matter may change from year to year.

ECE 3463 Robotic Sensors 4 Q.H.
Winter Quarter

The main theme of this course is acquisition and processing of information for robot control. The subject is divided into two parts along the functional use of sensory information. Internal sensors, which monitor the state of the robot system (joint load, balance, kinesthesia, temperature, etc.) are analyzed first. The external sensors, which allow the system to interact with the environment are the second major topic of the course. These include proximity, ranging and vision. Topics for study will be chosen from the following areas: low level vision, 3-D vision, real time image understanding, theory of shape, theory of motion, etc. The objective of the course is to analyze the pertinence of different sensory modalities to endow the next generation of robots with "intelligent" behavior. Students will be required to participate in the weekly research reviews. Each student will have to complete a design project by simulating relevant problems in LISP environment. *Prereq.: Permission of Instructor.*

ECE 3464 Robotic Sensors A 2 Q.H.
Fall Quarter

ECE 3464 and ECE 3465 cover the same material with the same prerequisites as ECE 3463, but in two 2QH courses.

ECE 3465 Robotic Sensors B 2 Q.H.
Winter Quarter

Continuation of ECE 3464. *Prereq.: ECE 3464.*

ECE 3466 Intelligent Robots 4 Q.H.
(formerly 03.874)**Spring Quarter**

The course focuses on studies of intelligent interactions between robots and their environments. An important issue is the implementation of a goal directed behavior with emphasis on sensory driven locomotion and manipulation. "Robot as an Intelligent Agent" is the general topic under which these concepts are introduced during the first three weeks of the course. The second major topic deals with attempts to constrain the problem of machine perception from an engineering point of view. Finally, the high level concepts such as learning, knowledge representation, adaptation and self-organization are discussed in the context of artificial intelligence. *Prereq.: ECE 3463.*

ECE 3467 Intelligent Robots A 2 Q.H.
Winter Quarter

ECE 3467 and ECE 3468 cover the same material with the same prerequisites as ECE 3466, but in two 2QH courses.

ECE 3468 Intelligent Robots B 2 Q.H.
Spring Quarter

Continuation of ECE 3467. *Prereq.: ECE 3467.*

ECE 3469 Fault-Tolerant Computers 4 Q.H.**Winter Quarter**

Concepts of computer systems structures and specifications; software and hardware interactions; failure and reliability; errors and faults. Study of different types of faults; fault prevention and fault tolerance; redundancy management; reliability and availability. Comparisons of existing fault-tolerant computer architectures such as SIFT, FTMP, Tandem 16, and Stratus/32. Techniques of error detection and error recovery. Mechanisms for damage confinement and damage assessment. Study of software fault tolerance techniques such as recovery block scheme, deadline mechanism, and N-version programming scheme. *Prereq.: ECE 3391.*

ECE 3470 Fault-Tolerant Computers A 2 Q.H.**Winter Quarter**

ECE 3470 and ECE 3471 cover the same material with the same prerequisites as ECE 3469, but in two 2QH courses.

ECE 3471 Fault-Tolerant Computers B 2 Q.H.**Spring Quarter**

Continuation of ECE 3470. *Prereq.: ECE 3470.*

**ECE 3501 Spectral Estimation Techniques 2 Q.H.
(formerly 03.8U1)****Spring Quarter**

Estimation of power spectra; the periodogram; modified periodogram; parametric methods for estimation of the power spectrum; autoregressive models; the Levinson algorithm; maximum entropy method and the Burg algorithm; moving average and autoregressive-moving average models; maximum likelihood methods; applications of methods in communications; speech processing and seismic signal processing. *Prereq.: ECE 3321*

**ECE 3502 Special Topics in Digital
Signal Processing-Fast Algorithms 2 Q.H.
(formerly 03.8U4)****Spring Quarter**

Fast algorithms for implementation of digital filters and discrete Fourier transforms: FFT, convolution algorithm, Number Theoretic Transforms (NTT), filtering computation, and polynomial transforms. *Prereq.: ECE 3321.*

**ECE 3503 Two-Dimensional Digital
Signal Processing (formerly 03.8U7) 2 Q.H.****Winter Quarter**

This course is concerned with two-dimensional digital signal processing which is finding wide applications in many diversified areas. Covers 2-D shift invariant systems along with their stability, the 2-D Discrete Fourier Transform (DFT) and its FFT implementation, and 2-D digital filter design and implementation. *Prereq.: ECE 3321.*

**ECE 3504 Digital Processing of Speech
Signals (formerly 03.9B1) 2 Q.H.****Fall Quarter**

Models of speech production, waveform coding of speech, transform coding of speech and speaker recognition systems. *Prereq.: ECE 3321.*

**ECE 3505 Digital Image Processing 4 Q.H.
(formerly 03.9D3)****Spring Quarter**

An introduction to the generation and processing of digital images. The course emphasizes the random-vector nature of digital images and uses linear system theory, matrices, and probability theory to develop the various topics. These include the generation of a digital image from the source, through the optical system, to the detector; sampling and quantization of the optical signal; and the enhancement techniques such as histogram mapping, contrast boosting, and edge sharpening. Image restoration by Weiner filtering, maximum entropy estimation, singular value decomposition, and spatially varying filters, image coding with Huffman codes, DPCM, Transform (Walsh, KL, discrete cosine) coding, run-length encoding, adaptive optics, feature analysis, and hardware for a typical digital image processing system. *Prereq.: ECE 3321.*

**ECE 3506 Digital Image Processing A 2 Q.H.
(formerly 03.9D1)****Fall Quarter**

ECE 3506 and ECE 3507 cover the same material with the same prerequisites as ECE 3505, but in two 2QH courses.

**ECE 3507 Digital Image Processing B 2 Q.H.
(formerly 03.9D2)****Winter Quarter**

Continuation of ECE 3506. *Prereq.: ECE 3506.*

**ECE 3511 Data Communications Networks 4 Q.H.
(formerly 03.8F6)****Spring Quarter**

Elements of computer-communication networks; network topology and design; elements of protocols, routing and network control; queuing and congestion control; description and comparison of several existing computer networks. *Prereq.: ECE 3241.*

**ECE 3512 Data Communications Network A 2 Q.H.
(formerly 03.8F4)****Winter Quarter**

ECE 3512 and ECE 3513 cover the same material with the same prerequisites as ECE 3511, but in two 2QH courses.

**ECE 3513 Data Communications Network B 2 Q.H.
(formerly 03.8F5)****Spring Quarter**

Continuation of ECE 3512. *Prereq.: ECE 3512.*

**ECE 3514 Error Correcting Codes 4 Q.H.
(formerly 03.9A0)****Spring Quarter**

Error correcting codes and their decoding techniques which show promise for applications in digital communication, control and computer systems. Emphasis is placed on the linear block codes based on algebraic structures; cyclic codes for random error correction (B-C-H codes) and burst error correction. Convolutional codes and decoding including the Viterbi algorithm, arithmetic codes. Combination

of codes. Coding for ranging and synchronization.
Prereq.: ECE 3211.

ECE 3515 Error Correcting Codes A 2 Q.H.
(formerly 03.9A1)

Winter Quarter

ECE 3515 and ECE 3516 cover the same material with the same prerequisites as ECE 3514, but in two 2QH courses.

ECE 3516 Error Correcting Codes B 2 Q.H.
(formerly 03.9A2)

Spring Quarter

Continuation of ECE 3515. *Prereq.: ECE 3515.*

ECE 3517 Information Theory 2 Q.H.
(formerly 03.903)

Spring Quarter

Deals principally with three aspects of information theory; the statistical description of sources and probabilistic measure of their information contents, the determination of channel capacity; and the fundamental coding theorems. *Prereq.: ECE 3211 and ECE 3351.*

ECE 3520 Special Topics in 2 Q.H.
Communication Theory (formerly 03.908)

Spring Quarter

Current aspects of communication theory not covered in previous courses. Subject matter may change from year to year.

ECE 3523 Communication Systems 4 Q.H.
(formerly 03.870)

Fall Quarter

Primarily concerned with radio communication systems as used in terrestrial and space communication applications. Antenna gain, space loss, cosmic and atmospheric noise, and receiver noise are considered as factors influencing the signal-to-noise ratio in space and satellite repeater systems. Contemporary systems are discussed from the standpoint of signal spectrum, noise power and message ambiguity as exhibited at the output of the intermediate frequency receiver. The theoretical aspects of amplitude and angle modulation systems are introduced and extended to cover multiplex systems; signal-to-noise ratio analysis of frequency multiplex systems; time division multiplex systems. Coverage of digital systems will include sampling, aliasing, and PCM/FM. Bit stream organization for transmission will be considered. A PCM encoder will be discussed as a means of matching the bit stream to the bandwidth. Illustrative examples will be drawn from contemporary communications systems used on balloons, rockets, and satellite repeaters. *Prereq.: ECE 3241 and ECE 3104 or equivalent.*

ECE 3524 Communication Systems A 2 Q.H.
(formerly 03.871)

Fall Quarter

ECE 3524 and ECE 3525 cover the same material with the same prerequisites as ECE 3523, but in two 2QH courses.

ECE 3525 Communication Systems B 2 Q.H.
(formerly 03.872)

Winter Quarter

Continuation of ECE 3524. *Prereq.: ECE 3524.*

ECE 3527 Nonlinear Systems I 2 Q.H.
(formerly 03.910)

Fall Quarter, As Announced

Operators and functionals. Functional power series representation of nonlinear systems. Functional representation of the response of a nonlinear system when its input is either a constant, a sinusoid, or a transient. System transforms. Applications to the analysis and synthesis of nonlinear systems in terms of functional power series. *Prereq.: ECE 3241 and ECE 3221.*

ECE 3528 Nonlinear Systems II 2 Q.H.
(formerly 03.911)

Winter Quarter, As Announced

Nonlinear systems with random inputs. Functional representation of the response of a nonlinear system when its input is a random process. Orthogonal systems of functionals. Representation and analysis of nonlinear systems in terms of orthogonal systems of functionals. The optimum nonlinear filter, predictor, and general operator. Special classes of nonlinear systems. Determination of optimum nonlinear systems for generalized error criteria. *Prereq.: ECE 3527.*

ECE 3529 Nonlinear Systems III 2 Q.H.
(formerly 03.912)

Spring Quarter, As Announced

Functional analysis of systems characterized by nonlinear differential equations. Operator approach to system theory and its relationship to differential equation representations. The methods of iteration in nonlinear theory and its application to feedback systems. *Prereq.: ECE 3528.*

ECE 3530 Three-Dimensional Picture 2 Q.H.
Processing (formerly 03.887)

Spring Quarter

The application of computer, optical, and analytic methods in abstracting geometrical information from pictures. Pictorial presentation of data trains into multidimensional pictures. Methods will be studied for reconstructing three-dimensional objects from two-dimensional pictures. Applications will be in the areas of X-ray analysis, radar target identification, microscopy, and sensory perception. Students will have the chance to pursue individual projects during the term. *Prereq.: ECE 3321.*

ECE 3540 Digital Control Systems 4 Q.H.
(formerly 03.8D6)

Spring Quarter

Analysis of linear discrete-time dynamic systems; discretization of continuous systems; sampling and aliasing. Design of digital control systems using transform techniques by discrete equivalent and direct design methods; root locus, Bode and Nyquist diagrams and Nichols charts. Multivariant digital control using state-space methods; pole placement, ob-

server, and regulator design. Controller implementation issues: digital filter realizations, nonlinear effects due to quantization, roundoff, deadband, limit cycles. Selection of the sampling rate. *Prereq.: ECE 3221.*

ECE 3541 Digital Control Systems A 2 Q.H.
(formerly 03.8D4)

Fall Quarter

ECE 3541 and ECE 3542 cover the same material with the same prerequisites as ECE 3540, but in two 2QH courses.

ECE 3542 Digital Control Systems B 2 Q.H.
(formerly 03.8D5)

Winter Quarter

Continuation of ECE 3541. *Prereq.: ECE 3541.*

ECE 3543 Stochastic Control Theory 4 Q.H.
(formerly 03.965)

Fall Quarter

Statistical models for random signals; representation of dynamic systems excited by stochastic inputs. Optimal filtering, prediction and smoothing for discrete and continuous systems. Observer theory and feedback of estimated states for effective closed-loop control in a noisy environment. Estimation theory for dynamic systems based on Bayesian and maximum likelihood methods. The system identification problem. Implementation of numerical algorithms for parameter identification and adaptive control. *Prereq.: ECE 3241 and ECE 3371.*

ECE 3544 Stochastic Control Theory A 2 Q.H.
(formerly 03.963)

Winter Quarter

ECE 3544 and ECE 3545 cover the same material with the same prerequisites as ECE 3543, but in two 2QH courses.

ECE 3545 Stochastic Control Theory B 2 Q.H.
(formerly 03.964)

Spring Quarter

Continuation of ECE 3544. *Prereq.: ECE 3544.*

ECE 3560 Acoustics I 2 Q.H.
(formerly 03.817)

Fall Quarter

The wave theory of sound. Radiation, reflection, and transmission phenomena. Distributed system analogies, and sound measurements. *Prereq.: ECE 3341.*

ECE 3561 Acoustics II 2 Q.H.
(formerly 03.818)

Winter Quarter

Speech and hearing, microphones and loudspeakers, guided waves, room acoustics. Environmental acoustics. *Prereq.: ECE 3560.*

ECE 3562 Acoustics III 2 Q.H.
(formerly 03.819)

Winter Quarter

Scattering and diffraction. Effects of viscosity and heat conduction. Finite amplitude and shock waves. Introduction to underwater sound. *Prereq.: ECE 3561.*

ECE 3564 Radar Systems I 2 Q.H.
(formerly 03.865)

Fall Quarter

Emphasis on the systems aspects of radar engineering. Topics covered include basic theory of radar detection, measurement of range, angle, and Doppler shift; classes of radar systems; types of radar noise; components of a radar system; matched filters and correlation receivers as applied to radar systems; fundamental ideas of radar system analysis. *Prereq.: ECE 3241.*

ECE 3565 Radar Systems II 2 Q.H.
(formerly 03.866)

Winter Quarter

In-depth study of search radar theory; maximum likelihood estimation approach to measurement of radar target parameters; resolution and ambiguity functions applied to radar; radar parameter uncertainty principles. *Prereq.: ECE 3564.*

ECE 3566 Radar Systems III 2 Q.H.
(formerly 03.867)

Spring Quarter

Advanced topics in radar systems engineering. Topics to be covered include: design considerations for multistatic radar systems, synthetic aperture radars; tracking systems; radar waveform synthesis; multi-function array radar techniques and selected topics in radar sensing techniques and devices. *Prereq.: ECE 3565.*

ECE 3568 Microwave Engineering 2 Q.H.
Principles I (formerly 03.880)

Fall Quarter

Review of electromagnetic theory concepts directly applicable to analysis of microwave devices and systems. Theory of transmission lines and waveguides. *Prereq.: ECE 3341.*

ECE 3569 Microwave Engineering 2 Q.H.
Principles II (formerly 03.881)

Winter Quarter

Circuit theory for waveguide systems. Impedance matching and transformation. Passive microwave devices. Cavity resonators. *Prereq.: ECE 3568.*

ECE 3570 Microwave Engineering 2 Q.H.
Principles III (formerly 03.882)

Spring Quarter

Advanced topics in microwave theory. Topics to be covered include: propagation in anisotropic media; nonreciprocal and ferrite devices; beam-wave interactions; coupled mode theory; traveling wave devices; periodically loaded lines; couplers; polarizers; phase shifters; attenuators; microwave filter synthesis; microwave systems considerations. *Prereq.: ECE 3569.*

ECE 3572 Fourier Optics I 2 Q.H.
(formerly 03.916)

Winter Quarter

This two-quarter sequence covers: optical diffraction and imaging problems as linear systems; necessary

tools of Fourier analysis and linear systems analysis which occur when solving the scalar wave equation; waves and their properties; reflection, refraction, polarization, and propagation of waves; foundations of scalar diffraction theory—including Fresnel and Fraunhofer diffraction, interferometry, division of amplitude, division of wavefront, interferometric instrumentation, Fourier transforming, image properties of lenses, coherent and incoherent imaging; and advanced topics in the application of communication theory to optical problems, transfer and spread functions, spatial filtering, and holography. *Prereq.: ECE 3581.*

ECE 3573 Fourier Optics II 2 Q.H.
(formerly 03.917)

Spring Quarter

Continuation of ECE 3572. *Prereq.: ECE 3572.*

ECE 3574 Fourier Optics III 2 Q.H.
(formerly 03.983)

Fall Quarter

This course covers current topics of interest in Fourier optics and optical instrumentation. Application of coherence phenomena to optical instrumentation such as microdensitometers, microscopes, viewers, cameras, spectrophotometric and interferometric instruments; applications of holography, optical data processing and computing, holographic memories, optical modulation, noise and its effects on data collection, synthetic aperture optics and medical application of laser optics. *Prereq.: ECE 3573.*

ECE 3576 Lasers I 2 Q.H.
(formerly 03.806)

Fall Quarter

Review of basic optical principles and atomic physics; introduction to optical coherence; models for the interaction of electromagnetic radiation with matter; a general description of lasers is given. *Prereq.: ECE 3341.*

ECE 3577 Lasers II 2 Q.H.
(formerly 03.807)

Winter Quarter

Laser threshold and rate equations; elementary resonator theory and fabrication; giant pulse operation; specific solid-state, liquid, and gas lasers; and laser systems. *Prereq.: ECE 3576.*

ECE 3578 Lasers III 2 Q.H.
(formerly 03.808)

Spring Quarter

Applications of lasers and laser systems for a variety of engineering and basic science disciplines; specific laser optoelectronic devices. *Prereq.: ECE 3577.*

ECE 3580 Electro-Optics I 2 Q.H.
(formerly 03.914)

Spring Quarter

Survey of the basic concepts necessary for understanding and evaluating the optics involved in electro-optical systems. The optical system as a linear system; matrix methods; diffraction and interference; imaging and aberrations. *Prereq.: Bachelor of Science Degree in Engineering or Physics.*

ECE 3581 Electro-Optics II 2 Q.H.
(formerly 03.915)

Fall Quarter

Survey of the basic concepts necessary for understanding electro-optical devices. Wave propagation in isotropic and non-isotropic media; optics of crystals; polarization; optical resonators; guided waves; modulators and detectors; thin-film optics. *Prereq.: ECE 3580.*

ECE 3583 Optical Properties of Matter I 2 Q.H.
(formerly 03.921)

Fall Quarter

Optics of crystals; classification and effects of crystal symmetry on optical properties; classical description of wave propagation in crystals; applications of the theory to modulation, pulse generation, nonlinear optics. *Prereq.: Bachelor of Science Degree in Engineering or Physics.*

ECE 3584 Optical Properties of Matter II 2 Q.H.
(formerly 03.922)

Winter Quarter

Introduction to electro-optical and magneto-optical effects in material media; linear and nonlinear optical materials; elasto-optic and acousto-optical materials; polarization and propagation effects; modulation. *Prereq.: ECE 3583.*

ECE 3585 Optical Properties of Matter III 2 Q.H.
(formerly 03.923)

Spring Quarter

Thin films and optical fibers; multilayer filters; dichroics; integrated optics. *Prereq.: ECE 3584.*

ECE 3587 Principles of Optical Detection I 2 Q.H.
(formerly 03.981)

Winter Quarter

Laws governing radiation and radiometry; properties of real radiation sources; detailed description of detection devices (image forming and signal generating); noise; contrast and MTF; detection systems (imaging devices and ranging devices); electro-optical detector systems analysis. *Prereq.: Bachelor of Science Degree in Engineering or Physics.*

ECE 3588 Principles of Optical Detection II 2 Q.H.
(formerly 03.982)

Spring Quarter

Review of detector parameters; statistics of detector noise; practical considerations in real detectors; detection, resolution and recognition of signals; heterodyne detection and parametric amplification; subnanosecond pulse detection calibration of electro-optical detectors; detectors as system components. *Prereq.: ECE 3587.*

ECE 3589 Optical Storage and Display 2 Q.H.
(formerly 03.913)

Spring Quarter

Survey of materials and methods for the storage and display of information. Topics included are: photographic film, holograms, storage tubes, magneto-optical films, photochromic materials, electro-optical crystals, evaporated thin films and liquid crystals. *Prereq.: Bachelor of Science in Engineering or Physics.*

ECE 3590 Optical Instrumentation Design 2 Q.H.
(formerly 03.980)**Fall Quarter**

An introduction to the design of optical instrumentation. Principles and basic concepts of optical systems. In sequence the topics are: introduction, mechanical shock and vibration, kinematic designs; application of third-order aberrations, simple optical ray tracing, optical testing, tolerances, optical instrumentation, philosophy, functional design, design for quantity production, quality assurance, "special order" design, industrial design, examples and exercises. *Prereq.: Bachelor of Science in Engineering or Physics.*

ECE 3591 Spectroscopic Instrumentation 2 Q.H.
(formerly 03.984)**Winter Quarter**

Survey of optical instrumentation employed in analysis and control situations; modern methods of spectrometry and interferometry; optimization of analytical systems; topics in electron spectroscopy, X-ray spectroscopy, microwave spectroscopy, and related fields. *Prereq.: ECE 3581.*

ECE 3592 Remote Sensing 2 Q.H.
(formerly 03.886)**Spring Quarter, As Announced**

The application of electromagnetic radiating for sensing the environment, subsurface geophysical exploration, and identifying remote objects. Basic goals are concerned with understanding the relevant electromagnetics in relation to the particular sensing system. Both time and frequency-domain sensing systems will be covered. As time permits, the application of pattern recognition methods to electromagnetic sensing will be discussed. *Prereq.: ECE 3341 or ECE 3343.*

ECE 3593 Plasma Engineering 2 Q.H.
(formerly 03.800)**Fall Quarter, As Announced**

Behavior, diagnostics, and generation of plasma and gas discharges; emphasis on the engineering and experimental point of view rather than on a rigorous theoretical treatment. Current literature on a variety of plasma engineering applications will be introduced throughout the course. First-quarter topics include: dynamics of charged particles in static electric and magnetic fields, E and M wave-plasma interactions, infinite and finite media, elastic and inelastic collisions. *Prereq.: ECE 3341.*

ECE 3594 Plasma Theory 4 Q.H.
(formerly 03.803)**Winter Quarter, As Announced**

Plasma electrodynamics and linear response theory. Fluid and Vlasov descriptions of plasmas with and without magnetic fields. Dispersion and damping of collective modes. Beam-plasma linear instabilities and application to shock-wave structures. Plasma electrodynamics and nonlinear response theory. Fluctuation-Dissipation theorems. Sum rules. New approaches to strongly correlated plasmas: equation of state, liquid-solid phase transitions, dispersion

and damping of collective modes. Role of strongly correlated plasmas in laser- and heavy-particle beam-inertial confinement schemes in thermonuclear fusion. *Prereq.: ECE 3341.*

ECE 3595 Plasma Theory A 2 Q.H.
(formerly 03.801)**Winter Quarter, As Announced**

ECE 3595 and ECE 3596 cover the same material with the same prerequisites as ECE 3594, but in two 2QH courses.

ECE 3596 Plasma Theory B 2 Q.H.
(formerly 03.802)**Spring Quarter, As Announced**

Continuation of ECE 3595. *Prereq.: ECE 3595.*

ECE 3597 Thermonuclear Fusion 2 Q.H.
Energetics I (formerly 03.810)**Fall Quarter, As Announced**

Application of the concepts developed in ECE 3593 and ECE 3595 to the problem of thermonuclear plasmas. Emphasis will be on magnetic confinement schemes. Both open (mirror machines) and closed (torroidal confinement machines) systems will be discussed.

ECE 3598 Thermonuclear Fusion 2 Q.H.
Energetics I**(formerly 03.811)****Winter Quarter, As Announced**

Continuation of magnetic confinement schemes. Trapped particle instabilities and anomalous transport effects will be discussed. Introduction to interfacial confinement (laser fusion).

ECE 3599 Thermonuclear Fusion 2 Q.H.
Energetics III**(formerly 03.812)****Spring Quarter, As Announced**

Introduction to microinstabilities associated with laser fusion devices. Introduction to computer modeling of plasmas. Discussion of recent advances in thermonuclear plasma generation by relativistic electron beams. *Prereq.: ECE 3598.*

ECE 3610 Electronics of Analog Signal 4 Q.H.
Processing (formerly 03.8E3)**Spring Quarter, As Announced**

Analog signal acquisition and processing utilizing state of the art devices and circuit techniques such as adaptive filters in sampled data systems, CZTs for spectral analysis, correlated double sampling for improved S/N ratios and solid-state imaging systems. Linear and nonlinear processing with MOS, bipolar and CTDs such as CCDs and SAWs. Attention given to analog vs. digital approaches for implementation of similar applications, i.e., bandwidth requirements, throughput, accuracy, cost, etc. *Prereq.: ECE 3331 and ECE 3384.*

ECE 3611 Electronics of Analog Signal 2 Q.H.
Processing A (formerly 03.8E1)**Fall Quarter, As Announced**

ECE 3611 and ECE 3612 cover the same material with the same prerequisites as ECE 3610, but in two 2QH courses.

ECE 3612 Electronics of Analog Signal Processing B (formerly 03.8E2) 2 Q.H.

Winter Quarter, As Announced

Continuation of ECE 3611. *Prereq.: ECE 3611.***ECE 3613 UHF and Microwave Circuits and Systems (formerly 03.8H3)** 4 Q.H.

Spring Quarter, As Announced

Brief review of waveguides, cavities, and striplines and their common descriptors. Some practical components of the microwave circuit including couplers, circulators, isolators, bends and tees. Scattering parameter descriptors. Microwave and UHF sources and amplifiers including both vacuum and solid-state devices. Frequency multiplication. Mixers. Parametric oscillators and amplifiers. Hybrid and monolithic microwave integrated circuits. *Prereq.: ECE 3341 and ECE 3384.*

ECE 3614 UHF and Microwave Circuits and Systems A (formerly 03.8H1) 2 Q.H.

Fall Quarter

ECE 3614 and ECE 3615 cover the same material with the same prerequisites as ECE 3613, but in two 2QH courses.

ECE 3615 UHF and Microwave Circuits and Systems B (formerly 03.8H3) 2 Q.H.

Winter Quarter

Continuation of ECE 3614. *Prereq.: ECE 3614.***ECE 3616 Modern Active Circuit Synthesis and Design (formerly 03.845)** 4 Q.H.

Fall Quarter

Feedback systems, including multiloop amplifier design; techniques will be applied to integrated circuit realizations of basic active networks. Basic methods of active network synthesis are introduced through three commonly used approaches: feedback amplifier, negative impedance converter, and gyrator; structures of Sallen and Key, Kuh, Linvill, Yanagisawa, Rohrer, Kinariwals, Sepress, and Calahan; consideration of the practical realization of NICs, and gyrators, standard decomposition methods and sensitivity; work of Sandberg, Larky, Newcomb, Daniels, Horowitz, and Thomas. *Prereq.: ECE 3331.*

ECE 3617 Modern Active Circuits Synthesis and Design A (formerly 03.843) 2 Q.H.

Fall Quarter

ECE 3617 and ECE 3618 cover the same material with the same prerequisites as ECE 3616, but in two 2QH courses.

ECE 3618 Modern Active Circuits Synthesis and Design B (formerly 03.845) 2 Q.H.

Winter Quarter

Continuation of ECE 3617. *Prereq.: ECE 3617.***ECE 3619 Network Synthesis (formerly 03.832)** 4 Q.H.

Fall Quarter

Matrix circuit analysis including m-port parameter systems. Positive-real functions. Energy functions. Driving-point synthesis techniques for LC, RC, and RL networks. Driving-point synthesis of RLC net-

works. Properties of two-port networks. Two-port synthesis, including the parallel ladder realization. Lattice synthesis. *Prereq.: BSEE or ECE 3100 and ECE 3101.*

ECE 3620 Network Synthesis A (formerly 03.831) 2 Q.H.

Winter Quarter

ECE 3620 and ECE 3621 cover the same material with the same prerequisites as ECE 3619, but in two 2QH courses.

ECE 3621 Network Synthesis B (formerly 03.832) 2 Q.H.

Spring Quarter

Continuation of ECE 3620. *Prereq.: ECE 3620.***ECE 3622 Special Topics in Electronics— Analog MOS LSI Circuits (formerly 03.862)** 2 Q.H.

Spring Quarter

This course covers selected topics of practical importance in the design of analog MOS integrated circuits. Principal topics are: NMOS & CMOS technology and devices; MOS transistor analog switch; digital-analog converters; comparators; analog — digital converters; sampled analog filtering concepts; switched-capacitor filters. *Prereq.: ECE 3331 and ECE 3384.*

ECE 3623 Gate Array Design 4 Q.H.

Fall Quarter

This course covers the design, simulation, verification, and implementation of a CMOS gate array. It begins with a description of the VAX-based gate array design and logic simulator tools. The students will be given design examples of digital logic circuits which will be entered, verified, and simulated. A description of the GE CMOS Macrocell Circuit Library and an introduction to TEGAS Logic Simulator will be included. After the completion of this course, the GE Microelectronics Center, at Research Triangle Park, North Carolina, will fabricate the chosen student gate array design projects which can then be tested and evaluated. *Prereq.: ECE 3331.*

ECE 3624 Gate Array Design—A 2 Q.H.

Winter Quarter

ECE 3624 and ECE 3625 cover the same material with the same prerequisites as ECE 3623, but in two 2 QH courses.

ECE 3625 Gate Array Design—B 2 Q.H.

Spring Quarter

Continuation of ECE 3624. *Prereq.: ECE 3624.***ECE 3797 Engineer Degree Continuation (formerly 03.9Z3)** 0 Q.H.

Any Quarter

Candidates to sign up for thesis continuation if their thesis is not completed after they have registered for 3 consecutive quarters or 10 QH of EE degree thesis. Continuous registration is required until the candidate graduates.

ECE 3798 Master's Thesis Continuation (formerly 03.9X1) 0 Q.H.

Any Quarter

ECE 3799 PhD Continuation (formerly 03.9X4) Any Quarter	0 Q.H.	ECE 3888 Master's Seminar II (formerly 03.991) Any Quarter	2 Q.H.
Analytical and/or experimental work conducted under the auspices of the department. <i>Prereq.: Bachelor of Science degree in Engineering or Science.</i>		The preparation of a research paper suitable for publication in a professional journal; plus an oral presentation of this report. <i>Prereq.: ECE 3887.</i>	
ECE 3860 Master's Thesis (formerly 03.995) Any Quarter	8 Q.H.	ECE 3889 Doctoral Seminar (formerly 03.993) Any Quarter	0 Q.H.
Analytical and/or experimental work conducted under the auspices of the department. <i>Prereq.: Bachelor of Science degree in Engineering or Science.</i>		This requirement will be satisfied by the student presenting a seminar to the Electrical Engineering Department on a subject related to his/her PhD thesis. The thesis supervisor will coordinate the seminar. <i>Prereq.: Passing of PhD Qualifying Exam.</i>	
ECE 3861 Master's Thesis Any Quarter	4 Q.H.	ECE 3892 Doctoral Reading (formerly 03.997) Any Quarter	0 Q.H.
ECE 3862 Master's Thesis Any Quarter	2 Q.H.	Material approved by the candidate's adviser. (Only S or F grades will be assigned for this course.) <i>Prereq.: Passing of PhD Qualifying Exam.</i>	
ECE 3870 Engineer Degree Thesis (formerly 03.9Z2) Any Quarter	4 or 8 Q.H.	ECE 3893 Special Problems in Electrical Engineering (formerly 03.998) Any Quarter	2 or 4 Q.H.
Analytical and/or experimental work conducted under the auspices of the department. Minimum of 4 QH, maximum of 8 QH allowed per quarter. <i>Prereq.: Admission to Engineer Degree Program.</i>		Theoretical or experimental work under individual faculty supervision. <i>Prereq.: Consent of Department Chairman.</i>	
ECE 3871 Engineer Degree Thesis Any Quarter	4 Q.H.	ECE 3894 Engineer's Degree Reading (formerly 03.9Z1)	
ECE 3872 Engineer Degree Thesis Any Quarter	2 Q.H.	To be taken upon completion of 30 QH of satisfactory course work. <i>No credits toward course requirements are given.</i> Minimum of 4 QH, maximum of 8 QH allowed per quarter.	
ECE 3880 Doctoral Thesis (formerly 03.996) Any Quarter	0 Q.H.	ECE 3895 Engineer's Degree Reading Any Quarter	8 Q.H.
Theoretical and/or experimental work conducted under the auspices of the department. <i>Prereq.: Passing of PhD Qualifying Exam.</i>		ECE 3896 Special Problems in Electrical Engineering Any Quarter	4 Q.H.
ECE 3887 Master's Seminar I (formerly 03.990) Any Quarter	2 Q.H.		
A library survey of a selected topic in the general field of electrical engineering with an oral presentation based on this survey. Participation in the departmental seminar program of guest lectures. <i>Prereq.: Bachelor of Science degree in Engineering or Science.</i>			

Biomedical

OINT 3250 Engineering and Medicine I (formerly 93.901) Fall Quarter	2 Q.H.	OINT 3251 Biomedical Applications of Heat and Mass Transfer (formerly 93.911) Winter Quarter	2 Q.H.
The intersection of technology with medicine; historical development of bioengineering profession; its impact on society; study of activities embraced by the profession today; educational, training, and career opportunities in clinical, biomedical, and medical engineering for individuals at the BS, MS, and PhD levels; future goals of engineering in biology and medicine; and issues basic to the relationship between new medical technology and the efficiency and effectiveness of the health care system. <i>Prereq.: Bachelor of Science in Engineering or allied field.</i>		Bioheat equation; thermal transport in living systems, thermal properties; thermal techniques in the measurement of blood flow; applications of heat transfer in medicine including hyperthermia for cancer therapy, hypothermia for tissue and organ preservation and cryosurgery, thermal sources for implantable artificial heart; and thermography in cancer detection. <i>Prereq.: Bachelor of Science in Engineering or allied field.</i>	

**OINT 3252 Selected Topics in
Bioengineering (formerly 93.912)
Spring Quarter**

Study of biomedical engineering appropriate to topics selected from fields of biomaterials, nuclear medicine, radiation diagnosis and therapy, biological

2 Q.H.

transport processes, artificial organs, rehabilitation engineering, and microprocessor based clinical instruments. Introduction to medical technology assessment. *Prereq.: OINT 3250 or permission of instructor.*

Industrial Engineering

Each course description includes information on the expected quarter in which classes are usually offered. The quarters listed are presented here for planning purposes; however, the Graduate School of Engineering cannot guarantee that all courses will be offered. Students must refer to the Graduate School of Engineering Quarterly Course Offering sheets to determine what courses are actually offered in any given quarter and at what day and time.

**IIS 3101 Industrial Accounting for
Engineers**

2 Q.H.

Introduction of basic accounting principles and procedures; use of accounting data as a management tool; a practical covering of basic cost accounting procedures related to materials, labor, and manufacturing expense cost control; job order, process, and standard cost systems.

**IIS 3102 Introduction to Human Factors
Engineering**

2 Q.H.

A survey of the principal topics and areas of concentration in the field. Includes introductory concepts of sensory physiology and sensory performance; basic motor capabilities and limitations; concepts of the human as a processor of information; and methods of gathering human performance data. Normally the first course in the human factors areas for students without behavioral science background. *Prereq.: IIS 3113 or permission of instructor.*

IIS 3103 Basic Operations Research

4 Q.H.

An introduction to the theory and use of deterministic and stochastic models to represent industrial operations. Models included are those of linear programming, dynamic programming, inventory control, waiting lines, and Markov Chains. *Prereq.: IIS 3113.*

**IIS 3106 Elements of Structured
Programming**

2 Q.H.

An introductory course to the principles and techniques of top down structured programming. The host language is PASCAL and topics covered include assignment statements, logical expressions, control statements, data structures, recursion and pointers.

IIS 3111 Principles of COBOL

2 Q.H.

Fundamentals of computer programming in COBOL. Topics include elementary computer functioning, program organization, input/output operations, arithmetic and data-handling verbs, and program logic development through the use of flow charts. Storage and manipulation of large data files on magnetic tape are introduced. No prior computer experience is required.

**IIS 3112 Quantitative Methods for
Information Systems**

4 Q.H.

An introduction to the theory and use of deterministic and stochastic models in the context of computer and information systems. Models included are linear programming, dynamic programming, Monte Carlo simulation, Gant and Pert charts, multicriteria decision analysis and waiting lines. Class examples will emphasize applications in a computer and information systems environment.

IIS 3113 Basic Probability and Statistics

4 Q.H.

Fundamental concepts of probability. Events, sample space, discrete and continuous random variables. Density functions, mass functions, cumulative probability distributions, and moments generating functions. Expectation of random variables. Common discrete and continuous probability distributions including binomial, poisson, geometric, uniform, exponential, and normal. Multivariate probability distributions, covariance and independence of random variables. Sampling and descriptive statistics. Parameter estimation, confidence intervals, and hypothesis testing.

IIS 3114 Industrial Engineering Economy

4 Q.H.

Introduction of basic accounting principles and procedures; use of accounting data as a management tool; a practical covering of basic cost accounting procedures related to materials, labor, and manufacturing expense cost control; job order, process, and standard cost systems. Economic analysis in formulating business policies and selecting alternatives from possible engineering solutions to industrial problems, present worth, annual cost, and rate-of-return techniques using discrete compound interest calculations.

IIS 3115 Modula-2 for Engineers

4 Q.H.

Syntax and basic data structures of the Modula-2 language. Modules, procedures, and visibility control. Data structures, including enumerations, arrays, records, sets, and pointers. Sequential and screen-oriented input/output, recursion, concurrency and low-level facilities.

IIS 3116 Assembly Language 4 Q.H.

The study of microcomputer programming in assembly language with emphasis on structured programming techniques, interrupts, and input/output devices. Microprocessor programming model, instruction set, and addressing modes. Microcomputer system architecture, system resources, interrupt processing, input/output interfaces. *Prereq.: Higher level language.*

IIS 3117 Intensive Modula-2 2 Q.H.

Syntax and basic data structures of the Modula-2 language are covered. Modules and visibility control; overview of records, sets and pointers; sequential and screen oriented input/output, recursion, concurrency and low level facilities are included. *Prereq.: Structured programming language.*

IIS 3200 Organizational Perspectives and Project Management 4 Q.H.

A survey of business organization, management and operation, including business responsibility to its employees, its product, the customer and the environment in which it operates. Planning, forecasting, and budgeting; the financial markets; investing and speculating will be covered, as well as the interaction of politics, government and government controls on the industrial enterprise.

IIS 3201 Analysis of the Industrial Enterprise I 2 Q.H.

Same material as IIS 3200 offered as two 2 QH courses. *Prereq.: IIS 3201.*

IIS 3202 Analysis of the Industrial Enterprise II 2 Q.H.

Same material as IIS 3200 offered as two 2 QH courses. *Prereq.: IIS 3201.*

IIS 3204 Engineering/Organizational Psychology 4 Q.H.

An analysis of the purpose and functioning of organizations as the basic networks for achieving goals through coordination of effort, communication, and responsibility. The approach will emphasize the role and function of engineering organizations and will be based on modern behavioral science concepts. The course covers the application of psychology to industry relative to human relations, group dynamics, tests and measurements, personnel practices, training, and motivation.

IIS 3205 Industrial Organizations 2 Q.H.**IIS 3206 Industrial Psychology for Engineers 2 Q.H.**

Same material as IIS 3204 offered as two 2 QH courses. *Prereq.: IIS 3205.*

IIS 3207 Financial Management 4 Q.H.

Study of the issues and processes of short-term financing on industrial firms; financial analysis of cases, supplemented by readings to develop familiarity with sources and uses of working capital as well as the goals and problems involved in its management. Also covered is the analysis necessary for such long-term financial decisions as issuance of

stock or bonds; contracting of leases or loans, and financing of a new enterprise; mergers, capital budgeting, the cost of capital, and the valuation of a business. *Prereq.: IIS 3101 or IIS 3114 and IIS 3201 or equivalent.*

IIS 3208 Financial Management I 2 Q.H.

Prereq.: IIS 3101 or IIS 3114 and IIS 3201 or equivalent.

IIS 3209 Financial Management II 2 Q.H.

Same material as IIS 3207 offered as two 2 QH courses. *Prereq.: IIS 3208.*

IIS 3214 Engineering Communications 2 Q.H.

Exploration of practice in the preparation and presentation, both written and oral, of the results of engineering projects and programs as a basis for business decisions; including formal reports, progress summaries, memoranda, and technical papers. The effective use of various media and audiovisual aids based on both audience and material.

IIS 3216 Advanced Engineering Economy 2 Q.H.

Principal emphasis on the practical application of the techniques studied in basic engineering economy; problems of implementation through class discussion of cases and student projects; recent advances in the techniques of engineering economy, especially those relating to the consideration of uncertainties. *Prereq.: IIS 3114.*

IIS 3217 Engineering Project Management 4 Q.H.

The optimization of schedules utilizing pertinent software tools such as the linear programming and project management packages will be undertaken. Other graphics software used to draw project diagrams such as Gantt charts, PERT diagrams, manpower loading charts, and funding charts will be included. Determination of the critical path and comparison of actual performance with the planned schedule will be covered. The systems life cycle will be considered. Needs analysis, requirements definition, preliminary design, detailed design, and implementation will be addressed in the context of project management.

IIS 3218 Planning and Managing Information Systems Development 4 Q.H.

The computer system developmental life cycle. Interactions between the system and the organization. Design parameters and tradeoffs. Planning for externalities. Individual and organizational aspects of human decision making. Systems approach to planning, management, and control of effective information systems development. The course will be based on extensive use of case studies and will include some guest speakers. *Prereq.: IIS 3615.*

IIS 3219 Cost Accounting and Industrial Budgeting 4 Q.H.

Cost accounting procedures are studied and evaluated in terms of being considered by the engineer for cost determination of alternative engineering proposals and for input into various budgeting plans which the engineer may become involved with. An introduction to the essentials of fixed and variable

budgeting for production, inventory, sales, cash, capital, and cost-volume profit analysis will be provided. *Prereq.: IIS 3114.*

IIS 3220 Development of Engineering Personnel 4 Q.H.

The science and art of managing creative people employed in research, developmental, and engineering activities are considered with a view to understanding the problems encountered by such people and their managers in the course of their professional work. Attention is devoted to such behavioral theories and their applications in the practice of management. Emphasis is placed on each student's experiences as professionals or managers in diverse industrial settings.

IIS 3302 Advanced Work Design 2 Q.H.

Basic philosophies of work design; implementation of work design concepts with case studies; study and analysis of models such as work sampling, sequence or flow of work models; repetitive and nonrepetitive work models, and work measurement models such as standard data; human factors in measuring operator performance; regression analysis approaches; emphasis on development of professional, analytical, and managerial skills and abilities at a systems level. *Prereq.: Bachelor of Science degree in Engineering or Science.*

IIS 3303 Product Design and Value Analysis 2 Q.H.

Study of design parameters and their effect on development, manufacturing and procurement; functional analysis of components and systems; complete projects and case studies are integrated in the course.

IIS 3304 Production Analysis 4 Q.H.

Study of advanced problem-solving techniques in the areas of method and measurement, layout and facilities planning, material handling and manufacturing process. Case studies and a course project in a local concern illustrate the concepts presented.

IIS 3305 Case Studies in Industrial Engineering 2 Q.H.

Formulation of problems and analysis of situations on topics such as work measurement, line balancing, plant layout, regression analysis, wage and salary administration, management information systems and network analysis. Class discussion and written analysis of a variety of cases are included. *Prereq.: IIS 3304.*

IIS 3306 Network Planning and Control 2 Q.H.

Applications of stochastic networks to project management, scheduling, inventory, reliability, quality control and other industrial applications; review of PERT and its inadequacies, to the development of stochastic flow-graphs and networks; solving for the mean task times and variances using moment-generating functions; setting up the model for computer simulation using GERT. *Prereq.: IIS 3506 or IIS 3523.*

IIS 3307 Introduction to Microprocessors 2 Q.H.

A first course in microprocessor computing, covers hex codes for assembly language. Basics of architecture model, programming model and addressing modes. Instruction set for a typical machine. Programming techniques and details for a 6502 processor. Hands-on laboratory experimentation with typical interfacing problems. Case studies in the area of developing applications. Laboratory experimentation in a staffed facility. *Prereq.: Compiler level language.*

IIS 3308 Microcomputer Applications 2 Q.H.

System architecture of several microcomputers including: microprocessor, bus design, multichip operations and current trends in processors (8, 16, and 32 BIT). Interfacing problems and hardware to include: sensors, actuators, A/D, D/A converters, data transmission and parallel/serial I/O. Real time programming with case studies. Network and distributed processing. Also included are development techniques and current state-of-the-art trends. *Prereq.: IIS 3307 or permission.*

IIS 3309 Computer Methods in Manufacturing 2 Q.H.

In-depth coverage of the use of computers in selected areas of manufacturing systems design is presented. Possible topic areas are numerical control, MRP, process planning and control, and other important applications of computers to manufacturing systems. *Prereq.: IIS 3311 or permission.*

IIS 3310 Manufacturing Methods and Processes 4 Q.H.

Material covered includes the structures of polymers (thermoplastic, thermosetting and glasses). Manufacturing processes for polymers including thermofforming are included. Structure of metals, the manufacturing processes for metal forming are presented. Alloys and welding and brazing are also included.

IIS 3311 Computer-Aided Manufacturing 4 Q.H.

A first course (overview) of computer aided-manufacturing. Covers the areas that encompass the term CAM: group technology, material requirements planning, part coding and classification, numerical control, part programming and management systems. Broad coverage of each of the areas is given to allow the student to gain an appreciation of the automated factory. *Prereq.: Compiler level language.*

IIS 3312 Forecasting and Inventory Control 4 Q.H.

Econometric methods of forecasting the demand for industrial products; emphasis on techniques applicable to individual companies and the total demand. The principal tool used is the mathematical model of the causal factors with special attention to determining the reliability of the model. The design and operation of inventory systems from a scientific management point of view, including both required theory and practical aspects. Subjects include inventory control models and techniques, production planning, and control models and methods. *Prereq.: IIS 3523.*

IIS 3400 Human Factors Engineers 4 Q.H.

The course covers sensory motor and work environment considerations. Topics include the design of equipment and systems for human use, with the application of engineering psychology; visual and auditory presentation of information; human information processing and skilled task performance. The course examines the human as a work-performing, heat-generating physiological engine, and the implied restrictions on the equipment and workplace to provide occupational safety and effective man/machine performance. *Prereq.: IIS 3102.*

IIS 3401 Human Factors—Sensory Motor 2 Q.H.
*Prereq.: IIS 3102***IIS 3402 Human Factors—Work Environment 2 Q.H.**

Same material as IIS 3400 offered as two 2 QH courses. *Prereq.: IIS 3102.*

IIS 3403 Occupational Health and Safety 4 Q.H.
Winter Quarter

Topics include safety responsibilities of management and employees; recognition of chemical, electrical, and mechanical hazards; principles of machine guarding; accident investigation and cost analysis; record keeping requirements under OSHA Act of 1970; safety programs and inspections; safety training; toxology, first aid and medical services; fire prevention and control methods; occupational diseases and personnel protective equipment.

IIS 3404 Introduction to Occupational Health and Safety 2 Q.H. each

IIS 3405 Technical Aspects of Health and Safety
Same material as IIS 3403 offered as two 2 QH courses. *Prereq.: IIS 3404.*

IIS 3406 Man-Computer Interaction 2 Q.H.

Design and evaluation of the man-computer interface in on-line information systems; formatting of visual displays and auditory outputs, techniques to facilitate operator inputs, pacing and control of the interactive sequence, operator training, task analysis and performance testing. Student projects in areas of novel application. *Prereq.: IIS 3401.*

IIS 3407 Human Factors Engineering—Data Base 2 Q.H.

Prereq.: IIS 3509.

IIS 3408 Human Factors Engineering—Application Methods 2 Q.H.

Same material as IIS 3410 offered as two 2 QH courses. *Prereq.: IIS 3102.*

IIS 3409 Topics in Physiology and Biomedical Engineering 2 Q.H.

Introduction to specific areas relating to human structure and function, and to the use of engineering techniques for medical diagnosis and therapy. Areas considered include blood and blood components, the cardiovascular system, the kidney and urinary systems and respiratory systems. The course will be taught on a seminar basis. Students will be required

to do literature research under the guidance of the instructor. *Prereq.: Permission of instructor.*

IIS 3410 Advanced Human Factors Engineering 4 Q.H.

The study of methods and techniques used to obtain and interpret human performance data. Includes examination of experimental methods and problems peculiar to experimentation with human subjects; unobtrusive measures, and nonreactive techniques; survey design and implementation; systematic observation techniques. Also covered are systems analysis and man/machine systems; function and task analysis; task allocation; support equipment and training design; error analysis; occupational safety; preconstruction; periodic and accident/critical incident analytic techniques. *Prereq.: IIS 3509 and IIS 3400.*

IIS 3500 Principles of Dynamic Systems 4 Q.H.

Introduction to modeling of social systems, emphasizing the study of feedback structures and their behavior; mechanisms underlying growth, stagnation and cyclical fluctuation; formulation of models of industrial, economic, social, and ecological systems; study of the effects of delays, multiple feedback loops, and nonlinearities. The aim is to build an intuitive foundation for simulation studies of complex systems and obtain exercise in model conceptualization.

IIS 3501 Principles of Dynamic Systems I and 2 Q.H. each**IIS 3502 Principles of Dynamic Systems II**

Same material as IIS 3500 offered as two 2 QH courses. *Prereq.: IIS 3501.*

IIS 3503 Simulation Methodology and Applications 4 Q.H.

Course covers when, where, and how to use discrete event simulation techniques. Topics include model design, development, and validation; tactical and strategic planning considerations in the use of the model; input data reduction; alternative programming languages for implementing models; efficiency in running simulations, and statistical reliability in the design and analysis of simulation experiments. Several special purpose simulation languages are discussed, e.g., SIMSCRIPT, GPSS, and SIMAN. *Prereq.: IIS 3506 or IIS 3523 and compiler-level language.*

IIS 3506 Statistics 4 Q.H.

Basic tools of statistical inference are covered. These include limit theorems; point and interval estimators and properties of estimators; Bayes Hypothesis and hypothesis testing; one- and two-sided tests; power curve; nonparametric tests; statistical models for predication and analysis of random phenomena; multiple regression analysis; correlation; design and analysis of simple experiments. *Prereq.: IIS 3113.*

IIS 3509 Design of Experiments 4 Q.H.

Theory and application of experimental design techniques such as modeling and statistics which can optimize resources and improve decision making risks. This course will cover experiments with single and

multiple factors of interest and consider experiments with high order experimental restrictions. Some additional analyses techniques will also be covered. *Prereq.: IIS 3506.*

IIS 3512 Queuing Theory and Its Applications 2 Q.H.

A development of the theory of queues with emphasis on-practical applications, using the latest techniques of Markovian state-transition diagrams to simplify the mathematic model; study of models based on random arrivals and departures including exponential and Erlang service distributions, single and multiple services, series and parallel systems, finite and infinite queues; applications to staffing, inventory control, reliability, maintenance and scheduling. *Prereq.: IIS 3103.*

IIS 3514 Advanced Operations Research 4 Q.H.

Important families of mathematical programming problems and optimization methods will be covered: The revised simplex algorithm and the decomposition principle for large size multidivisional problems. Generalized networks, including the transshipment, shortest route, maximal flow and the minimal spanning tree problems. The cutting plane and the branch and bound algorithm for binary and mixed integer programming problems. Introduction to nonlinear programming including unconstrained optimization and the Kuhn-Tucker conditions. *Prereq.: IIS 3103.*

IIS 3517 Statistical Decision Theory 2 Q.H.

Use of Bayesian statistical inference to arrive at decisions when stochastic variables are interacting; relationship to game theory; decision making over time in a sequence; important expected values and distributions; relationship of Bayesian decision theory to classical statistical inference. *Prereq.: IIS 3506 or IIS 3523.*

IIS 3518 Advanced Quality Control 2 Q.H.

Mathematical methods of quality control; development of the process control charts for sampling by variables and by attributes; development of acceptance test procedures; development of life-testing plans; cost aspects of quality-control decisions. *Prereq.: IIS 3506 or IIS 3523.*

IIS 3519 Reliability Theory in Design 2 Q.H.

An introduction to the mathematical theory of the reliability of non-maintained systems and their application in the design of hardware and equipments in general; application of active and standby redundancy in systems; reliability predictions; stress-denoting techniques; availability concepts; design reviews and managerial control. *Prereq.: IIS 3506 or IIS 3523.*

IIS 3521 Reliability Analysis of Complex Systems 2 Q.H.

A Markovian-chain state-transition diagram approach to reliability modeling of non-maintained and maintained systems which permits analytic steady-state and dynamic solutions of both the stationary and non-stationary models; setting up the matrix-equations

for solution by computer; controlling the numerical oscillations and accuracy of the results. *Prereq.: IIS 3519.*

IIS 3522 Systems Engineering Design and Analysis 4 Q.H.

The course covers principles of systems modeling and analysis using continuous simulation techniques. Topics include differential equations as system models; Laplace transformations; numerical approximation techniques; stability; steady-state error; control actions; alternative modeling scheme; and validation of system models via continuous simulation techniques. Emphasis is placed on concepts from the production and service-oriented industries. *Prereq.: Compiler-level language.*

IIS 3523 Applied Statistics 4 Q.H.

Development of complete statistical models for the predication and analysis of random phenomena. Topics include goodness of fit and nonparametric tests; analysis of variance; simple and multiple regression. Introduction to the design of experiments, quality control, decision analysis, reliability, and risk assessment. *Prereq.: IIS 3113.*

IIS 3524 Advanced Operations Research Topics 4 Q.H.

Nonlinear programming including gradient methods, separable, quadratic and geometric programming. Introduction to multicriteria decision analysis including the generation of nondominated solution set, goal programming, and continuous and discrete solution methods. *Prereq.: IIS 3103.*

IIS 3525 Introduction to Reliability Analysis and Risk Assessment 4 Q.H.

Introduction to probability theory, classical and Bayesian statistics useful for reliability analysis of large, complex systems. The course covers Bayesian probability encoding of experience data; principles of the methods or risk assessment and reliability analyses including fault trees, decision trees, and reliability block diagrams. Practical applications to industrial operations—e.g., nuclear and chemical plants, military systems, large processing plants—are treated.

IIS 3526 Advanced Reliability Analysis, Risk Assessment, and Maintenance 4 Q.H.

Extended application and use of reliability and probabilistic risk analysis methods. Methods for common cause/dependent failure analysis, human reliability analysis, and treatment of uncertainties. Bayesian statistics applied to data analysis and discrete probability distribution (DPD) arithmetic for propagation of uncertainty. Time-dependent reliability analysis, Markov models, availability, and maintenance theory. Replacement and maintenance strategy development. The role of maintenance in improving systems reliability, performance, and productivity. The Deming method of quality control. Case studies in industrial system. *Prereq.: IIS 3525.*

IIS 3600 Basic Computer Systems Technology**2 Q.H.**

Introduction to computer systems and assembly language programming using a language such as VAX MACRO. Topics include: machine language, and assemblers. Input/output device control. Students are required to prepare and test several programs. *Prereq.: Compiler level language.*

IIS 3601 Compiler Design**4 Q.H.**

An introduction to data structures, including stacks and trees. The nature of compiling and interpreting, string manipulation, and code generation. The writing of a compiler in assembly language of a BASIC-like source language will be started. The compiler design work is completed as a term project. *Prereq.: IIS 3600 or IIS 3116.*

IIS 3604 Data Structures and Introduction to Data Base Management**4 Q.H.**

Treats the topics of computer files, file organization and processing, list and tree organization, and maintenance controls, for quality, protection, and security. Introduction to data base systems and their rise in corporations. Review of basic data storage concepts. Evolution and growth of data bases. Data organization, file creation, and management, using hashing, threaded lists, tree structures. Distributed data bases. Data base software, directory maintenance, types of data base languages, query languages. Data base management systems. Data base administration. *Prereq.: IIS 3615 or equivalent.*

IIS 3607 Operating Systems and Systems Software**4 Q.H.**

A study of the components of operating systems, including resource allocation management, multi-tasking, scheduling, and I/O. Major software elements of a computer system are considered, including loaders, linkers, assemblers, compilers, and interpreters. *Prereq.: IIS 3604 or IIS 3600.*

IIS 3610 Computer Architecture**4 Q.H.**

This course embodies how modern computers are designed and organized from a number of levels including the fundamental circuits memory, control, and I/O, as well as how alternative designs and architecture affect and are affected by software. Topics to be covered include: elementary digital circuits, including registers, multiplexers, and circuits used in arithmetic operations, control, and I/O; memory organization; microprogramming; busses and I/O channels; example architectures, including PDP 11, IBM 360/370, and a typical microprocessor; multi-tasking; virtual systems. *Prereq.: IIS 3600.*

IIS 3613 Principles of Software Design**2 Q.H.**

Techniques for solving complex computer programming tasks include run-time structures in programming languages; communication, linking, and sharing of programs and data; interface design; program documentation; maintenance modification; testing and debugging. Current topics in program design such as readability, data abstraction, step-wise refinement and structured programming are also covered. *Prereq.: IIS 3607.*

IIS 3614 Basic Information System Technology**2 Q.H.**

Introduction to the hardware and software which support computer-based management information systems, design, development, and operation. Topics include CPU instruction cycle; data conversion and data entry devices; secondary memory types; output and display devices; machine-oriented and high-level computer languages. Objective of the course is to develop capability in specifying software and equipment configuration appropriate to support a given set of management informational needs.

IIS 3615 Analysis and Design of Computer Information Systems**4 Q.H.**

Introduction to computer information systems analysis and design techniques and the hardware and software which support such systems. Topics covered include: techniques for determining information requirements for MIS/DSSs; development of the functional systems design; computer system design considerations such as the CPU, main memory, operating systems functions, computer languages, input devices, secondary memory, file organization, data-base management systems, data communications, data security, and output and display devices. The main objective of the course is to develop capability in the skeletal design of a computer system to support a given set of management needs.

IIS 3616 MIS: Planning and Managing the Contributions to the Decision Process**4 Q.H.**

Phases of MIS design and development are examined from a planning and control viewpoint. Techniques are presented for conceptual identification of a continuing stream of information system candidate projects, for achieving a user-oriented assessment of cost/benefit potential, and for control of the design and implementation effort. Case study discussions are used extensively to apply principles to realistic situations.

IIS 3617 Management Information Systems**2 Q.H.**

The development of a conceptual framework which emphasizes support to management decision making. Relevant cognitive and organizational characteristics of human decision making are integrated into a systems analysis approach to development of effective information systems. Case study discussions are used extensively to apply principles to realistic situations. *Prereq.: IIS 3614 or IIS 3615.*

IIS 3618 MIS: Planning, Control and Development**2 Q.H.**

Phases of MIS design and development are examined from a planning and control viewpoint. Techniques are presented for conceptual identification of a continuing stream of information system candidate projects, for achieving a user-oriented assessment of cost/benefit potential, and for control of the design and implementation effort. Case study discussions are used extensively to apply principles to realistic situations. *Prereq.: IIS 3614 or IIS 3615.*

IIS 3620 Computerized Financial Control Systems**2 Q.H.**

Considers on-line systems for financial and inventory control from the technological, legal, and social point of view. The focus of the course is on electronic funds transfer (EFT) and point of sale (POS) terminals and associated computing equipment for inter-bank and consumer banking transactions, debit card transactions, and retail management information systems to control cash and inventory. The current technological status and societal implications of EFT and POS terminals are discussed. *Prereq.: IIS 3614 or IIS 3615.*

IIS 3621 Information Systems and Society**2 Q.H.**

Discussion of the role computer systems play in modern society. The beneficial use of computers in commercial and industrial enterprises is considered and contrasted with the potential for infringement of individual privacy rights. Sufficient technical material on computer hardware, software, and data communications is discussed to permit assessment of system feasibility. Relevant major legislation is related to current practice in use of computer systems.

IIS 3622 Information Systems in a Microcomputer Environment**4 Q.H.**

Explores the role of microcomputers, networks of microcomputers, and larger machines in providing decision-aiding information. Topics include elements of office automation, local area networks, data communications, and micro- and minicomputer-based decision-support software. Emphasis is placed on the application of software packages to case problems. Specific IBM software includes KnowledgeMan, Superwriter, Lotus 1-2-3, dBase II, and Number Cruncher. On the VAX11/780, exposure to Runoff, INGRES, and DATATRIEVE will be provided. *Prereq. IIS 3614 or equivalent.*

IIS 3623 File Processing**2 Q.H.**

Processing of sequential, indexed-sequential, and direct/relative data files on tape and disk; record blocking, searching, sorting, and merging operations; random access techniques; introduction to data base management concepts, and if time permits an introduction to RPG. *Prereq.: Knowledge of COBOL programming.*

IIS 3624 Software Engineering I**4 Q.H.**

An introduction to software design techniques (software design methodology, programming methodology, software maintenance, software testing). Special emphasis on modular design. Modular design using Modula-2. *Prereq.: IIS 3115 or IIS 3117.*

IIS 3625 Software Engineering II**4 Q.H.**

An examination of software engineering principles through case studies of large software projects. The case studies serve as testbeds for software testing tools such as file comparators, program debuggers, and interactive debuggers. *Prereq.: IIS 3624.*

IIS 3626 Networks and Telecommunications**4 Q.H.**

Network goals and applications; architecture, topologies, and protocols; layered communications protocol design; layer functions, interlayer interfaces, and peer processes; performance measures; data communication techniques; wide area and local networks; channel interfaces and access schemes; workstations and server nodes; distributed systems; internetworking.

IIS 3627 Software Economics**4 Q.H.**

An examination of the COCOMO model (Constructive Cost Model) in the software life cycle will be included. Cost effectiveness analysis, multiple-goal decision analysis, figures of merit and marginal analysis techniques will be covered. *Prereq.: IIS 3624.*

IIS 3650 Engineering Analysis Utilizing Data Processing**2 Q.H.**

Application of computers and major high-level computer languages to the solution of engineering problems. FORTRAN and GPSS are employed in applications drawn from production and service-oriented industries to illustrate topics such as generation of random numbers, inventory simulation models, file search and sorting techniques, and root-finding algorithms. The software packages SPSS and MPOS are introduced. *Prereq.: Compiler level language.*

IIS 3651 Software Engineering Project**8 Q.H.**

Individual work under faculty supervision. *Prereq.: IIS 3624, IIS 3625, and permission of instructor.*

IIS 3797 Engineer Degree Continuation**0 Q.H.****IIS 3798 Master's Thesis Continuation****0 Q.H.****IIS 3799 PhD Continuation****0 Q.H.****IIS 3801 Special Project in Industrial Engineering****2 Q.H.**

Individual work under faculty supervision. *Prereq.: Permission of instructor.*

IIS 3802 Special Project in Industrial Engineering**4 Q.H.**

Same as IIS 3801.

IIS 3803 Independent Study in Operations Research Any Quarter**2 Q.H.**

Special topics in Operations Research by arrangement with a faculty member.

IIS 3804 Special Topics**4 Q.H.**

Special topics in IE and IS. *Prereq.: Permission of instructor.*

IIS 3805 Special Topics**2 Q.H.**

Special topics in IE and IS. *Prereq.: Permission of instructor.*

IIS 3806 Seminar in Industrial Engineering**2 Q.H.**

Discussion and presentations of thesis-related topics by students, presentations and discussions by

faculty and eminent people in the field on timely industrial engineering topics. Field trips and visitations included where appropriate. *Prereq.: Permission of instructor.*

IIS 3863 Thesis (Master's Degree) 8 Q.H.
Analytical and/or experimental work conducted under the auspices of the Department. *Prereq.: Consent of adviser.*

IIS 3861 Thesis (Master's Degree) 4 Q.H.
Same as IIS 3863.

IIS 3862 Thesis (Master's Degree) 2 Q.H.
Same as IIS 3863.

IIS 3870 Industrial Engineer Degree 10 Q.H.
Project
Undertaken with the approval of the candidate's adviser and the Department Graduate Committee.

IIS 3871 Industrial Engineer Degree 4 Q.H.
Project
Same as IIS 3870.

IIS 3872 Industrial Engineer Degree 2 Q.H.
Project
Same as IIS 3870.

IIS 3873 Industrial Engineer Degree 8 Q.H.
Project
Same as IIS 3870.

IIS 3880 Doctoral Thesis 10 Q.H.
Doctoral thesis research conducted under advisership of the doctoral student's dissertation committee.

IIS 3881 Doctoral Thesis 4 Q.H.
Same as IIS 3880.

IIS 3882 Doctoral Thesis 2 Q.H.
Same as IIS 3880.

IIS 3883 Doctoral Thesis 8 Q.H.
Same as IIS 3880.

Mechanical Engineering

Each course description includes information on the expected quarter in which classes are usually offered. The quarters listed are presented here for planning purposes; however, the Graduate School of Engineering cannot guarantee that all courses will be offered. Students must refer to the Graduate School of Engineering Quarterly Course Offering sheets to determine what courses are actually offered in any given quarter and at what day and time. 'Odd' and 'Even' years refer to the fall quarter of the academic year, i.e., Spring '85 which is in the 84-85 academic year, would be an 'Even' year.

ME 3100 Mathematical Methods for 4 Q.H.
Mechanical Engineers (formerly 02.825)
Fall Quarter
Embodies the material in ME 3101 and ME 3102. *Prereq.: Admission to the Graduate School of Engineering.*

ME 3101 Mathematical Methods for 2 Q.H.
Mechanical Engineers I (formerly 02.826)
Fall Quarter
Bessel and Legendre functions: boundary-value problems and series of orthogonal functions. Partial differential equations and applications to heat transfer, fluid flow, vibrations and wave propagation. *Prereq.: Admission to the Graduate School of Engineering.*

ME 3102 Mathematical Methods for 2 Q.H.
Mechanical Engineers II (formerly 02.827)
Winter Quarter
Vector analysis; divergence theorem; functions of a complex variable; Laurent series and singular points; residues and contour integration; applications. *Prereq.: Admission to the Graduate School of Engineering.*

ME 3120 Theory of Elasticity 4 Q.H.
(formerly 02.807)
Fall Quarter
Embodies the material in ME 3121 and ME 3122. *Prereq.: Admission to the Graduate School of Engineering.*

ME 3121 Theory to Elasticity I 2 Q.H.
(formerly 02.804)
Fall Quarter
Analysis of Cartesian tensors using indicial notation. Stress and strain concepts; point stress and strain; relation to tensor concepts. Governing equations for the determination of stress and displacement distributions in a solid body. Exact solutions of the governing equations for elastic solids. *Prereq.: Admission to the Graduate School of Engineering.*

ME 3122 Theory of Elasticity II 2 Q.H.
(formerly 02.805)
Winter Quarter
Plane stress and strain problems in rectangular and polar coordinates including thermal stress. Relation of elasticity theory to strength of materials. Torsion of prismatic and axially symmetric bars. Bending of thin flat rectangular and circular plates. *Prereq.: ME 3121.*

ME 3140 Advanced Dynamics 4 Q.H.
Fall Quarter
Embodies the material in ME 3141 and ME 3142. *Prereq.: Admission to the Graduate School of Engineering.*

ME 3141 Advanced Dynamics I 2 Q.H.
(formerly 02.847)
Fall Quarter
Kinematics of particles and rigid bodies. Modeling and application of fundamental laws of motion. Dy-

dynamic response of lumped parameter systems. *Prereq.: Admission to the Graduate School of Engineering.*

ME 3142 Advanced Dynamics II 2 Q.H.
(formerly 02.848)

Winter Quarter

Continuation of ME 3141. Lagrange's equations. Applications in two and three dimensions. *Prereq.: ME 3141.*

ME 3200 General Thermodynamics 4 Q.H.
(formerly 02.903)

Winter Quarter

Fundamentals of equilibrium thermodynamics will be examined. Topics include: work, energy, heat, temperature, available energy, entropy, first and second laws of thermodynamics, simple systems, closed and open systems, availability loss and irreversibility, heat engines, multicomponent systems, mixtures of gases, chemical reactions and chemical equilibrium. Equivalent to courses ME 3201 and ME 3202. *Prereq.: Admission to the Graduate School of Engineering.*

ME 3201 General Thermodynamics I 2 Q.H.
(formerly 02.901)

Fall Quarter

ME 3201 and ME 3202 present the same material contained in ME 3200 but in two 2QH courses. *Prereq.: Admission to the Graduate School of Engineering.*

ME 3202 General Thermodynamics II 2 Q.H.
(formerly 02.902)

Winter Quarter

Continuation of ME 3201. *Prereq.: ME 3201.*

ME 3210 Essentials of Fluid Dynamics 4 Q.H.
(formerly 02.821)

Fall Quarter

This is a fundamental course in fluid dynamics designed to prepare the student for more advanced courses in the thermofluids curriculum while providing a strong background in fluid mechanics. Topics to be covered may include: Cartesian tensors; differential and integral formulation of the equations of conservation of mass, momentum and energy; molecular and continuum transport phenomena; The Navier-Stokes equations; Vorticity; inviscid, incompressible flow, the velocity potential and Bernoulli's equation; viscous incompressible flow; the stream function; some exact solutions; energy equation including heat conduction and viscous dissipation. This material is also covered in the two 2QH courses ME 3211 and ME 3212. *Prereq.: Admission to the Graduate School of Engineering.*

ME 3211 Essentials of Fluid Dynamics I 2 Q.H.
(formerly 02.819)

Fall Quarter

ME 3211 and ME 3212 present the same material with the same prerequisites as ME 3210, but in two 2QH courses. *Prereq.: Admission to the Graduate School of Engineering.*

ME 3212 Essentials of Fluid Dynamics II 2 Q.H.
(formerly 02.820)

Winter Quarter

Continuation ME 3211. *Prereq.: ME 3211.*

ME 3250 Advanced Physical Metallurgy I 2 Q.H.
(formerly 02.953)

Fall Quarter, Odd Years

The kinetics of phase transformations in metals. Topics include kinetic theory, empirical kinetics, diffusion in metals, nucleation, diffusional growth, martensitic transformations. *Prereq.: A recent introductory material science course.*

ME 3251 Advanced Physical Metallurgy II 2 Q.H.
(formerly 02.954)

Winter Quarter, Odd Years

Dislocation theory; including such topics as dislocation stress fields, self-energy, velocity, interactions mechanisms, image forces, and theories of yielding. *Prereq.: A recent introductory material science course.*

ME 3260 Thermodynamics of Materials I 2 Q.H.
(formerly 02.960)

Fall Quarter, Odd Years

Basic metallurgical thermodynamics encompassing first, second, and third laws, entropy, enthalpy, and free energy. *Prereq.: Engineering materials.*

ME 3261 Thermodynamics of Materials II 2 Q.H.
(formerly 02.961)

Winter Quarter, Odd Years

Continuation of ME 3260 with emphasis on solutions, activity, activity coefficients, the phase rule and applications to some metallurgical problems. *Prereq.: ME 3260.*

ME 3270 Material Science and Engineering I (formerly 02.970) 2 Q.H.

Fall Quarter, Even Years

Principles underlying the structure and properties of solid materials. The relationships of these principles to the properties and to applications in structures and devices. Both macroscopic-phenomenological and electronic-molecular approaches will be used. Materials will include metals and alloys, semiconductors, and dielectrics. Typical subjects are atomic and electronic structures, ordering, nucleation, crystal growth, and thermal properties. *Prereq.: A recent introductory material science course.*

ME 3271 Material Science and Engineering II (formerly 02.971) 2 Q.H.

Winter Quarter, Even Years

Continuation of ME 3270 into additional topics such as electric, magnetic, and optical properties; applications of solid-state phenomena to achieve functions embodied in transducers, filters, amplifiers, energy converters, and so forth. *Prereq.: ME 3270.*

ME 3341 Power Generating Systems I 2 Q.H.
(formerly 02.935)

Fall Quarter

Power generating systems that employ fossil, nuclear, and heat recovery boilers operating in conjunction

with steam and organic Rankine cycles are examined. The steady-state and transient operation of each power-generating system is studied from both an analytical and conceptual point of view. The effect that site conditions, fuel quality, plant loading schedule and environmental regulations have on system design, performance and operation is presented. *Prereq.: ME 3200 or equivalent, or may be taken concurrently with permission of instructor.*

ME 3342 Power Generating Systems II 2 Q.H.
(formerly 02.936)

Winter Quarter

An extension of ME 3341. The same type of examination is conducted of systems incorporating gas, hydraulic, and wind turbines, solar and fuel cells, energy storage, combined cycles, and cogenerating systems. The objective of Power Generating Systems I and II is to develop the skills needed to conduct sound technical evaluations of the power generating systems being built today. *Prereq.: ME 3341.*

ME 3343 Power Generation Economics 2 Q.H.
and Planning (formerly 02.938)

Spring Quarter

Current and constant-dollar power generation costs are examined. Life-cycle economic analysis, such as revenue requirements, discounted cash flow, internal rate of return, and payback analyses are presented. The planning methodologies used by electric utilities and private industry to evaluate and select power generating systems are presented. *Prereq.: ME 3342.*

ME 3351 Solar Thermal Engineering I 2 Q.H.
(formerly 02.855)

Fall Quarter, Odd Years

A model is developed for the hourly direct and diffuse radiation under a cover of scattered clouds and the transmission and absorption of this radiation by passive and active systems. The design of air heating systems and the storage of the collected energy by a pebble-bed are considered, as well as elements of heat exchanger design. A study of the economics of a domestic water and/or space heating system is made using f-chart analysis. *Prereq.: CHE 3659, Solar Energy Thermal Processes or equivalent background.*

ME 3352 Solar Thermal Engineering II 2 Q.H.
(formerly 02.856)

Winter Quarter, Odd Years

The design and analysis of several solar thermal systems are considered, such as: LiBr-H₂O absorption cooling units, heat pumps, compound parabolic collectors, and the heat pipe type of solar collector. *Prereq.: ME 3351.*

ME 3361 Turbomachinery Design I 2 Q.H.
(formerly 02.930)

Fall Quarter

Preliminary design methods and analytical tools applicable to turbomachinery in general, including velocity diagram selection and limitations of diffusion, are presented. Design criteria and performance characteristics at design and off-design operating

conditions are discussed for several important types of turbomachinery. Axial flow compressors and turbines (gas and steam) are studied in some depth, including topics such as compressor surge, turbine blade cooling, and steam wetness effects. Centrifugal compressors, radial inflow turbines, pumps, fans, and water turbines are also studied. Turbomachinery mechanical design limitations are discussed. The use of empirical data on blade cascade performance in blade selection is examined. Numerical methods of analyzing two- and three-dimensional flows in turbomachinery (e.g., conformal transformation and streamline curvature) are presented. Two in-depth design projects (one per quarter) are assigned. *Prereq.: Admission to the Graduate School of Engineering, and undergraduate preparation in fluid mechanics and thermodynamics.*

ME 3362 Turbomachinery Design II 2 Q.H.
(formerly 02.931)

Winter Quarter

Continuation of ME 3361. *Prereq.: ME 3361.*

ME 3380 Fundamentals of Instrumentation 2 Q.H.
(formerly 02.853)

Fall Quarter

Theoretical principles underlying the design and operation of instruments for measurement and/or control. Analysis of stimulus-response relations. Industrial instruments for measurement and control, including those based on pneumatic and electrical systems. *Prereq.: Bachelor of Science degree.*

ME 3381 Industrial Process Control 2 Q.H.
(formerly 02.854)

Winter Quarter

Fundamental principles involved in automatic control of industrial processes. Economic considerations. Application of control instruments to obtain automatic control of temperature, pressure, fluid flow, liquid level, humidity, PH. *Prereq.: ME 3380.*

ME 3386 Nuclear Engineering I 2 Q.H.
(formerly 02.942)

Fall Quarter, Even Years

Topics include: growth of nuclear power industry; study of nuclear physics emphasizing atomic and nuclear structure, radioactive decay, and nuclear reactions with particular attention to fission and fusion; radiation health physics; principles of shielding; nuclear instrumentation; production and application of radioisotopes; neutron interactions and slowing down theory; neutron activation analysis. (Not open to students who have completed ME 1541 and ME 1542). *Prereq.: Admission to the Graduate School of Engineering.*

ME 3387 Nuclear Engineering II 2 Q.H.
(formerly 02.943)

Winter Quarter, Even Years

Comparison of thermal, fast, and breeder reactors; four factor formula and the neutron diffusion equation; one-group, modified one-group, two-group and multi-group theory; bare and reflected thermal reactors; energy production and distribution within

core; flux shaping; transient reactor behavior and control; factors affecting reactivity including temperature, pressure, void formation, fission product accumulation, fuel depletion and fuel breeding; Xenon buildup after shutdown. (Not open to students who have completed ME 1541 and ME 1542). *Prereq.*: ME 3386.

ME 3388 Nuclear Engineering III 2 Q.H.
(formerly 02.944)

Spring Quarter, Even Years

Reactor design considerations; interrelationship of reactor physics, control, engineering, materials, safety, and fuel cycle management; reactor types; radiation damage and reactor materials; nuclear fuels; reactor heat transfer; economics of nuclear power; environmental effects. (Not open to students who have completed ME 1541 and ME 1542). *Prereq.*: ME 3387.

ME 3401 Advanced Math Methods for 2 Q.H.
Mechanical Engineers I (formerly 02.828)

Spring Quarter, Even Years

Matrices and linear equations. Variational calculus and applications. Approximate methods of engineering analysis. Selected topics of current interest. *Prereq.*: ME 3101 and ME 3102.

ME 3402 Advanced Math Methods for 2 Q.H.
Mechanical Engineers II

Spring Quarter

Integral transforms; asymptotic expansion; regular and singular perturbation methods. Examples drawn from solid mechanics, vibration, and fluid mechanics. *Prereq.*: ME 3101 and ME 3102.

ME 3410 Numerical Methods in 4 Q.H.
Mechanical Engineering

All Winter Quarters, Fall Quarter, Even Years

Numerical methods applied to problems in mechanical engineering. Solution of linear and nonlinear systems of equations, interpolation, numerical differentiation and integration, numerical solution of ordinary differential equations: explicit and implicit methods, multistep methods, predictor-corrector methods. Numerical solution of partial differential equations with emphasis on parabolic and elliptic problems occurring in mechanical engineering. This material is also covered in the two 2QH courses ME 3411 and ME 3412. *Prereq.*: ME 3100.

ME 3411 Numerical Methods in 2 Q.H.
Mechanical Engineering I

As Announced

ME 3411 and ME 3412 present the same material with the same prerequisites as ME 3410, but in two 2QH courses.

ME 3412 Numerical Methods in 2 Q.H.
Mechanical Engineering II

As Announced

Continuation of ME 3411. *Prereq.*: ME 3411.

ME 3420 Mechanics of Inelastic Solids 4 Q.H.
Spring Quarter

Constitutive relations governing inelastic solids. Yield surface; plastic stress-strain relations; Prandtl-Reuss equations. Viscoelastic stress-strain relations including the Maxwell and Voigt models. Viscoplasticity. *Prereq.*: ME 3122. Not available to students who have taken ME 3421.

ME 3421 Introduction to Plasticity 2 Q.H.
(formerly 02.809)

Winter Quarter, Even Years

Basic experimental information. Review of stress and strain tensors. Elastic stress-strain relations. Yield surface. Plastic stress-strain relations. Prandtl-Reuss equations. Simple applications. *Prereq.*: ME 3121.

ME 3423 Advanced Theory of Elasticity 2 Q.H.
(formerly 02.806)

Spring Quarter

Approximate solutions for stress and displacement distributions in elastic solids; discrete solutions using finite difference and finite element methods; energy principles and the calculus of variations; use of energy principles to obtain approximate continuous solutions. *Prereq.*: ME 3122, *Theory of Elasticity II*.

ME 3432 Engineering Fracture 2 Q.H.
Mechanics (formerly 02.838)

Fall Quarter, Odd Years

Fundamentals of brittle fracture; theoretical strength, micro/macro fracture characteristic, Inglis-Griffith theory, applicability of same. Linear elastic fracture mechanics; Orowan/Irwin extension to metals, effective surface tension and relation to fracture toughness, plastic zone size correction; geometry effects on fracture toughness; plane strain/plane stress fracture toughness, thickness effects. *Prereq.*: ME 3122.

ME 3433 Engineering Fracture 2 Q.H.
Mechanics (formerly 02.839)

Winter Quarter, Odd Years

Experimental determination of fracture toughness; slow crack growth "pop in," arrest, R-G curves, compliance techniques for determining elastic energy release rate. Alternate fracture toughness concepts; resistance curve, crack opening displacement, the J integral. Application of fracture mechanics to fatigue. Design methods to minimize risks of catastrophic failure will be emphasized. *Prereq.*: ME 3432.

ME 3434 Engineering Fracture 2 Q.H.
(formerly 02.829)

Spring Quarter, Odd Years

Application of fracture mechanics to fatigue, strain energy density criteria for fracture, arrest criteria. "Work of Fracture" specimen. Application of fracture mechanics to structural analysis. Effect of anisotropy in fracture mechanics. Fracture dynamics, dynamic fracture toughness, strain rate effects. Microsecond

fracture phenomenon and criteria, spall, Butcher-Tuler criterion, NAG model. Residual strength, design approaches will be emphasized. *Prereq.: ME 3433.*

ME 3440 Advanced Mechanics of Materials (formerly 02.812) 4 Q.H.

Winter Quarter

Embodies the material in ME 3441 and ME 3442. *Prereq.: Admission to the Graduate School of Engineering.*

ME 3441 Advanced Mechanics of Materials I (formerly 02.810) 2 Q.H.

Fall Quarter

Review of fundamental stress and deformation concepts; strain energy density; introduction to energy methods with application to beams, frames and rings; Ritz method. *Prereq.: Admission to the Graduate School of Engineering.*

ME 3442 Advanced Mechanics of Materials II (formerly 02.811) 2 Q.H.

Winter Quarter

Beams on elastic foundations. Concept of stability as applied to one and two degree-of-freedom systems. Buckling of bars, frames and rings. *Prereq.: ME 3441.*

ME 3443 Advanced Mechanics of Materials III (formerly 02.813) 2 Q.H.

Spring Quarter, Even Years

Selected topics in advanced mechanics; will vary with current interest. *Prereq.: ME 3442, Advanced Mechanics of Materials II or consent of the instructor.*

ME 3446 Theory of Shells (formerly 02.815) 2 Q.H.

Spring Quarter, Odd Years

Membrane theory of shells. Analysis of cylindrical shells. General theory of thin elastic shells. Shells of revolution. *Prereq.: ME 3122.*

ME 3455 Mechanics of Composite Materials (formerly 02.816) 2 Q.H.

Winter Quarter, Odd Years

Constitutive equations for anisotropic laminated composite materials, and application to the structural response of beams and plates. Bending and buckling of symmetric and nonsymmetric laminates. *Prereq.: ME 3121.*

ME 3465 Automatic Control Engineering A (formerly 02.849) 2 Q.H.

Fall Quarter, Even Years

Concepts of feedback control; formulation of equations, transfer functions, and block diagrams representing components and systems; linearization; Laplace transformation; stability. *Prereq.: Admission to the Graduate School of Engineering.*

ME 3466 Automatic Control Engineering I (formerly 02.850) 2 Q.H.

Winter Quarter, Even Years

Study of control action; analysis and design by use of root-locus and frequency-domain techniques. *Prereq.: ME 3465 or permission of instructor.*

ME 3467 Automatic Control Engineering II (formerly 02.851) 2 Q.H.

Spring Quarter, Even Years

Further consideration of linear systems including compensation methods and multiple-input. Techniques for the treatment of nonlinear systems. *Prereq.: ME 3466.*

ME 3468 Robot Mechanics and Control 4 Q.H.

Spring Quarter

Kinematics and dynamics of robot manipulators are the focus of the first part of the course. Kinematics cover the development of kinematic equations of manipulators, the inverse kinematic problems, and motion trajectories. Dynamics of manipulators for the purpose of control are covered employing Lagrangian mechanics. The second part of the course focuses on the control and programming of robot manipulators. Steady state errors and calculations of servo parameters are covered. High level programming languages are discussed. *Prereq.: ME 3142.*

ME 3470 Vibration Theory and Applications (formerly 02.844) 4 Q.H.

Winter Quarter

Embodies the material in ME 3472 and ME 3473. *Prereq.: ME 3142 or ME 3471.*

ME 3471 Vibration Theory and Applications A (formerly 02.841) 2 Q.H.

As Announced

Modeling of vibratory systems; one-degree-of-freedom systems (determination of equations of motion using free-body and energy methods); forced and free vibrations through two degrees of freedom. *Prereq.: Admission to the Graduate School of Engineering.*

ME 3472 Vibration Theory and Applications I (formerly 02.842) 2 Q.H.

Fall Quarter, Odd Years

Laplace transformation techniques; phase-plane diagrams; multiple-degree-of-freedom systems; free and forced vibrations with and without damping. *Prereq.: ME 3471 or ME 3142.*

ME 3473 Vibration Theory and Applications II (formerly 02.843) 2 Q.H.

Winter Quarter, Odd Years

Systems with distributed mass and stiffness. Extensional, torsional and flexural vibrations of bars. *Prereq.: ME 3472.*

ME 3474 Vibration Theory and Applications III (formerly 02.846) 2 Q.H.

As Announced

Selected topics of current interest in vibrations. *Prereq.: ME 3473.*

ME 3475 Random Vibration (formerly 02.845) 2 Q.H.

Spring Quarter, Odd Years

Description of stochastic processes. Impulse response and frequency response of linear time-invariant dynamic systems. Correlations and spectra of stationary response. Crossing rates, peaks and

envelopes. Failure under random loading. Poisson pulse processes. Measurement, identification, and response problems. Coherence. Space-time correlations and cross-spectra. Digital data processing. Application to vehicles and structures subjected to wide-band excitation. *Prereq.: ME 3473.*

ME 3480 The Finite Element Method 4 Q.H.
(formerly 02.949)

Spring Quarter

Embodies the material in ME 3481 and ME 3482. *Prereq.: ME 3101 and ME 3102 or consent of the instructor.*

ME 3481 Finite Element Analysis 2 Q.H.
(formerly 02.840)

Fall Quarter

Introduction to the finite element method. Variational formulations; simple interpolation functions and element stiffness matrices. Triangular and rectangular elements. Assembly technique and constraining of resulting equations. Elementary applications. *Prereq.: ME 3101 and ME 3102 or consent of the instructor.*

ME 3482 Advanced Finite Element 2 Q.H.
Method I (formerly 02.947)

Winter Quarter

Isoparametric element formulation of higher-order and three-dimensional elements. Rayleigh-Ritz and Galerkin formulations. Applications of finite element theory to mechanical engineering problems in the areas of solid mechanics, heat transfer, and fluid mechanics. The use of a finite element general purpose commercial package is included. *Prereq.: ME 3481.*

ME 3483 Advanced Finite Element 2 Q.H.
Method II (formerly 02.948)

Spring Quarter, Even Years

The dynamic finite element formulation with explicit and implicit time integration schemes for transient analysis. Solution methods for finite element equilibrium equations, including material and geometrical nonlinearities. The general structure of computer procedures and codes. Influence of computer-aided design technology. Use of an in-house general purpose commercial code is included. *Prereq.: ME 3482.*

ME 3500 Computer-Aided Graphics and 4 Q.H.
Design

Winter Quarter

Basic aspects of interactive computer graphics are covered. Topics include hardware and software concepts, design principles for the user-computer interface, geometrical transformation, display architecture, and data structures. Algorithms for removing hidden edges and surfaces, shading models, and intensity and colors are also covered. The second part of the course deals with the concepts of computational and numerical geometry and design of curves and surfaces. Solid modeling techniques are presented. Discussions of in-house computer-aided graphics and design packages are included. *Prereq.: Admission to the Graduate School of Engineering and programming experience.*

ME 3540 Heat Conduction and Thermal 4 Q.H.
Radiation (formerly 02.910 and 02.913)

Winter Quarter

Formulation of steady and unsteady state one- and multidimensional heat conduction problems. Solution techniques for linear problems including the method of separation of variables, Laplace transforms and integral transforms. Approximate analytical methods. Phase change problems. Nonlinear problems. Nature of thermal radiation. Blackbody and radiation from a blackbody. Radiation from a nonblack surface element. Radiative exchange among surfaces separated by a nonparticipating medium. Interaction of radiation with other modes of heat transfer in nonparticipating media. Numerical techniques in heat transfer are covered in ME 3410. Engineering. This material is also covered in the two 2QH courses ME 3541 and ME 3542. *Prereq.: ME 3100 and undergraduate course in heat transfer.*

ME 3541 Heat Conduction and Thermal 2 Q.H.
Radiation I (formerly 02.910)

Fall Quarter

ME 3541 and ME 3542 present the same material with same prerequisites as ME 3540, but in two 2QH courses.

ME 3542 Heat Conduction and Thermal 2 Q.H.
Radiation II (formerly 02.913)

Winter Quarter

Continuation of ME 3541. *Prereq.: ME 3541.*

ME 3544 Convective Heat Transfer 4 Q.H.
(formerly 02.911)

Winter Quarter, Even Years; Fall Quarter, Odd Years

Fundamental equations of convective heat transfer. Heat transfer in incompressible external laminar boundary layers. Integral boundary layer equations. Laminar forced convection in internal flows. Turbulent forced convection in internal and external flows. Analogies between heat and momentum transfer; the Reynolds, Taylor and Martinelli analogies. Natural convection. Heat transfer in high-speed flow. Transient forced convection. Convection and radiation in nonparticipating media. This material is also covered in the two 2QH courses ME 3545 and ME 3546. *Prereq.: ME 3100, ME 3210 and an undergraduate course in Heat Transfer.*

ME 3545 Convective Heat Transfer I 2 Q.H.
(formerly 02.911)

As Announced

ME 3545 and ME 3546 present the same material with the same prerequisites as ME 3544, but in two 2QH courses.

ME 3546 Convective Heat Transfer II 2 Q.H.
(formerly 02.911)

As Announced

Continuation of ME 3545. *Prereq.: ME 3545.*

ME 3548 Radiative Transfer 4 Q.H.
Spring Quarter

Electromagnetic background. Fundamentals of radiation in absorbing, emitting and scattering media.

Equation of radiative transfer. Approximate methods in the solution of the equation of radiative transfer. Singular-eigenfunction expansion technique. Pure radiative transfer in participating media. Interaction of radiation with conduction and/or convection. The Monte Carlo technique. This material is also covered in the two 2QH courses ME 3549 and ME 3550. *Prereq.: ME 3540.*

**ME 3549 Radiative Transfer I 2 Q.H.
As Announced**

ME 3549 and ME 3550 present the same material with the same prerequisites as ME 3548, but in two 2QH courses.

**ME 3550 Radiative Transfer II 2 Q.H.
As Announced**

Continuation of ME 3549. *Prereq.: ME 3549.*

**ME 3552 Two Phase Flow 4 Q.H.
Winter, Odd Years**

This course is aimed at the understanding of the basic concepts of heat and mass transfer associated with phase change and multiphase flows. Some of the specific subjects to be discussed are: boiling heat transfer (nucleate boiling, film boiling and bubble dynamics); evaporation and condensation; liquid-gas two phase flow and gas-solid and liquid-solid two phase flows. This material is also covered in the two 2QH course ME 3553 and ME 3554. *Prereq.: ME 3100 (or equivalent) and undergraduate heat transfer.*

**ME 3553 Two Phase Flow I 2 Q.H.
As Announced**

ME 3553 and ME 3554 present the same material as ME 3552 with the same prerequisites but in two 2QH courses.

**ME 3554 Two Phase Flow II 2 Q.H.
As Announced**

Continuation of ME 3553. *Prereq.: ME 3553.*

**ME 3556 Heat Transfer Processes in Microelectronic Devices 4 Q.H.
Spring Quarter**

The course will discuss and develop state-of-the art methods used to predict the heat transfer rates from microelectronic devices and packages and to simulate transport phenomena in manufacturing processes associated with microelectronic devices. Topics will be selected from the current literature and may include use of latent heat reservoirs, boiling jet impingement cooling, control volume approaches to extended surfaces, calculation of thermal contact conductances and natural convection in enclosures. Simulation of laser-assisted thermophoretic deposition and laser cladding processes will also be developed. This material is also contained in the two 2QH courses ME 3557 and ME 3558. *Prereq.: ME 3100 (or equivalent) and undergraduate heat transfer or consent of instructor.*

**ME 3557 Heat Transfer Processes in Microelectronic Devices I 2 Q.H.
As Announced**

ME 3557 and ME 3558 provide the same material as ME 3556 with the same prerequisites, but in two 2QH course.

**ME 3558 Heat Transfer Processes in Microelectronic Devices II 2 Q.H.
As Announced**

Continuation of ME 3557. *Prereq.: ME 3557.*

**ME 3560 Viscous Flow 4 Q.H.
Spring Quarter**

Review of conservation of mass, momentum, and energy for compressible viscous flow. Discussion of the mathematical character of the basic equations and analysis of some exact solutions. Investigation of low Reynolds number flow. Exact and approximate approaches to laminar boundary layers in high Reynolds number flows. Stability of laminar flows and the transition to turbulence. Treatment of incompressible turbulent mean flow; internal and external flows. Extensions to compressible boundary layers. This material is also covered in the two 2QH courses ME 3561 and ME 3562. *Prereq.: ME 3100 and ME 3210.*

**ME 3561 Viscous Flow I 2 Q.H.
As Announced**

ME 3561 and ME 3562 present the same material with the same prerequisites as ME 3560, but in two 2QH courses.

**ME 3562 Viscous Flow II 2 Q.H.
As Announced**

Continuation of ME 3561. *Prereq.: ME 3561.*

**ME 3564 Gas Dynamics 4 Q.H.
(formerly 02.823 and 02.824)
Spring Quarter, Even Years**

The consequences of fluid compressibility are studied. Shock waves and the theory of characteristics are discussed with specific consideration given to two-dimensional steady flows and one-dimensional unsteady flows. Additional topics may include axially symmetric steady flow, small perturbation theory, similitude rules, the hodograph method, or some aspects of physical acoustics. This material is also contained in the two 2QH courses ME 3565 and ME 3566. *Prereq.: ME 3210.*

**ME 3565 Gas Dynamics I 2 Q.H.
(formerly 02.823)**

As Announced

ME 3565 and ME 3566 present the same material with the same prerequisites as ME 3564, but in two 2QH courses. *Prereq.: ME 3210.*

**ME 3566 Gas Dynamics II 2 Q.H.
(formerly 02.824)**

As Announced

Continuation of ME 3565. *Prereq.: ME 3565.*

ME 3568 Computational Fluid Dynamics with Heat Transfer 4 Q.H.**All Spring Quarters, Fall Quarter, Odd Years**

Finite difference methods for solving partial differential equations with particular emphasis on the equations of fluid dynamics and convective heat transfer. Integral methods for boundary layers and their coupling to potential flow solutions. Use of coordinate transformations and body-oriented coordinate systems. Application of superposition techniques in convective heat transfer problems. This material is also covered in the two 2QH courses ME 3569 and ME 3570. *Prereq.: ME 3210 and ME 3410.*

ME 3569 Computational Fluid Dynamics with Heat Transfer I 2 Q.H.**As Announced**

ME 3569 and ME 3570 present the same material with the same prerequisites as ME 3568, but in two 2QH courses.

ME 3570 Computational Fluid Dynamics with Heat Transfer II 2 Q.H.**As Announced**

Continuation of ME 3569. *Prereq.: ME 3569.*

ME 3580 Statistical Thermodynamics (formerly 02.904) 4 Q.H.**Spring Quarter, Odd Years**

This is an introductory course in statistical thermodynamics for mechanical engineers designed to provide insight into the laws of classical thermodynamics and the behavior of substances. Topics to be covered include: introduction to probability; elementary kinetic theory of an ideal gas, including the distribution of molecular velocities and the mean free path treatment of transport properties; classical statistics of independent particles, equipartition of energy, the partition function and laws of thermodynamics; some results from quantum mechanics, quantum statistics of independent particles; applications to gases; introduction to ensembles and systems of interacting particles. This material is also contained in the two 2QH courses ME 3581 and ME 3582. *Prereq.: ME 3100 and ME 3200 or equivalent.*

ME 3581 Statistical Thermodynamics I (formerly 02.904) 2 Q.H.**As Announced**

ME 3581 and ME 3582 present the same material with the same prerequisites as ME 3580, but in two 2QH courses.

ME 3582 Statistical Thermodynamics II (formerly 02.904) 2 Q.H.**As Announced**

Continuation of ME 3581. *Prereq.: ME 3581.*

ME 3584 Fundamentals of Combustion (formerly 02.927) 4 Q.H.**Spring Quarter, Even Years**

Comprehensive treatment of the problems involved in the combustion of liquid, gaseous, and solid fuels in both laminar and turbulent flow. The fundamentals of chemical kinetics will be discussed. The equations

for the transport of mass, momentum, and energy with chemically reacting gases will be examined. Topics will include diffusion and premixed flames, combustion of droplets and sprays, and gasification and combustion of coal. This material is also presented in the two 2QH courses ME 3585 and ME 3586. *Prereq.: ME 3200.*

ME 3585 Fundamentals of Combustion I (formerly 02.927) 2 Q.H.**As Announced**

ME 3585 and ME 3586 present the same material as ME 3584, with same prerequisites, but in two 2QH courses.

ME 3586 Fundamentals of Combustion II (formerly 02.927) 2 Q.H.**As Announced**

Continuation of ME 3585. *Prereq.: ME 3585.*

ME 3600 Advanced Physical Metallurgy III (formerly 02.956) 2 Q.H.**Spring Quarter, Odd Years**

Mechanical behavior of metals. Application of dislocation theory to micro-plasticity, strain hardening, strengthening mechanisms and creep. *Prereq.: ME 3251.*

ME 3601 Thermodynamics of Materials III (formerly 02.963) 2 Q.H.**Spring Quarter, Odd Years**

The application of metallurgical thermodynamics to various process metallurgical problems, i.e., gas-solid systems, etc., plus kinetics of reactions and dynamic systems analysis. *Prereq.: ME 3260 or ME 3261.*

ME 3602 Materials Science and Engineering III (formerly 02.972) 2 Q.H.**Spring Quarter, Even Years**

Continuation of ME 3271 plus a discussion of various special topics that will vary from year to year. Examples are: metastable phases and thin films. *Prereq.: ME 3271.*

ME 3603 Corrosion (formerly 02.972) 2 Q.H.**As Announced**

This course will commence with the study of the thermodynamics of corrosion and corrosion reactions both in aqueous and non-aqueous environments. Topics will include thermodynamics, kinetics, and the effects of environment and physical metallurgy. Applications will be made to automotive design, and exterior and interior structures. *Prereq.: Admission to the Graduate School of Engineering.*

ME 3604 Oxidation (formerly 02.972) 2 Q.H.**As Announced**

This course will begin with the study of the thermodynamics of oxidation and the effect of environment on rates of oxidation. Topics will include thermodynamics, kinetics, mechanisms, and effect of environment. Ferrous and nonferrous metals as well as polymers will be assessed. *Prereq.: Admission to the Graduate School of Engineering.*

ME 3605 Electronic Materials I 2 Q.H.
Fall Quarter, Odd Years

Generic techniques for fabrication and processing, and the resulting structure-property relationships, are presented for materials utilized in electronics. Typically included are: bulk single crystals, thin films, metals, semiconductors, and insulators. *Prereq.: ME 3271.*

ME 3606 Electronic Material II 2 Q.H.
Winter, Odd Years

Continuation of ME 3605. *Prereq.: ME 3605.*

ME 3610 Introduction to Diffraction 2 Q.H.
Methods in Material Science (formerly 02.975)
Fall Quarter

General principles of the diffraction by materials of short wave length radiations; (such, as x-ray, electrons, and thermal neutrons) are studied with emphasis on the understanding of the similarities and differences of the different radiations when applied to the study of the structures of crystalline and non-crystalline materials. *Prereq.: A recent introductory material science course.*

ME 3611 Diffraction Methods in Material Science (formerly 02.976) 2 Q.H.
Winter Quarter

Continuation of ME 3610 with emphasis on the experimental methods and applications. This includes: choice of radiation, introduction to instrumentation, sample preparation, methods of detection and recording of the diffracted radiation, analysis, interpretation and use of the results. *Prereq.: ME 3610.*

ME 3612 Microstructure Analysis I 2 Q.H.
Fall Quarter, Even Years

Discussion of the principles of scanning and transmission electron microscopy. Image interpretation in transmission electron microscopy with emphasis on the study of the relationships between microstructure and properties of materials. Application of kinematical and dynamical theories of electron diffraction to quantitative analysis of point defects, dislocations, precipitates and grain boundaries etc. Laboratory demonstration of TEM and SEM operation. *Prereq.: Admission to the Graduate School of Engineering.*

ME 3613 Microstructure Analysis II 2 Q.H.
Winter, Even Years

Continuation of ME 3612. *Prereq.: ME 3612.*

ME 3620 Powder Metallurgy 2 Q.H.
(formerly 02.985)

Spring Quarter, Even Years

Powder characteristics and methods of manufacture. Powder pressing: packing, interparticle bonding, effects of pressure. Principles of sintering. Characteristics and properties of products made from powdered materials. *Prereq.: A recent introductory material science course.*

ME 3625 Physical Ceramics I 2 Q.H.
(formerly 02.965)

Fall Quarter, Even Years

Introduction to ceramic fabrication processes. Characteristics of vitreous and crystalline solids, structural imperfections, and atomic mobility. Phase equilibria, nucleation, crystal growth, solid-state reactions, non-equilibrium phases, and effects on the resulting microstructure of ceramics. *Prereq.: A recent introductory material science course, physical chemistry, or solid state physics.*

ME 3626 Physical Ceramics II 2 Q.H.
(formerly 02.966)

Winter Quarter, Even Years

Discussion of effects of composition and microstructure on the thermal, mechanical, optical, electrical, and magnetic properties of ceramic materials. *Prereq.: ME 3625.*

ME 3630 The Structure and Properties of Polymeric Materials I (formerly 02.958) 2 Q.H.

Fall Quarter, Even Years

Introduction to the organic chemistry of polymers, effect of chemical composition on structure, melting point and glass transition temperature, polymer characterization and degradation, thermodynamics of polymers. *Prereq.: Undergraduate material science course.*

ME 3631 The Structure and Properties of Polymeric Materials II (formerly 02.959) 2 Q.H.

Winter Quarter, Even Years

Rheology and mechanical behavior of polymers, analysis and testing, effects of processing on structure and physical properties, industrial polymers, resin base composites. *Prereq.: ME 3630.*

ME 3640 Computer Modeling of Materials Processing 2 Q.H.

Fall Quarter, Even Years

This course focuses on the use of numerical methods for modeling a variety of materials processes, e.g. melting, oxidation, reduction, the blast furnace, the cupola, rolling, extrusion. *Prereq.: Admission to the Graduate School of Engineering.*

ME 3641 Computer Modeling of Materials Properties 2 Q.H.

Winter Quarter, Even Years

Various mathematical techniques and computer methods will be used to develop models that describe the changes in a material's chemical, mechanical, and physical properties as the chemical composition and metallurgical variables are changed. *Prereq.: Admission to the Graduate School of Engineering.*

ME 3797 Engineer Degree Continuation 0 Q.H.
Any Quarter

ME 3798 Master's Degree Continuation 0 Q.H.
(formerly 02.9X1)
Any Quarter

ME 3799 PhD Continuation 0 Q.H.

Any Quarter

ME 3850 Special Problems in Mechanical Engineering (formerly 02.992) 2 Q.H.

Any Quarter

Theoretical or experimental work under individual faculty supervision. *Prereq.: Consent of department faculty.*

ME 3853 Special Topics in Mechanical Engineering (formerly 02.993) 2 Q.H.

Any Quarter

Topics of interest to the staff member conducting this class are presented for advanced study. *Prereq.: Permission of department faculty.*

ME 3856 Doctoral Reading 2 Q.H.
(formerly 02.994)

Any Quarter

Material approved by the candidate's adviser (only S or F grades will be assigned for this course). *Prereq.: Passing of PhD qualifying exam.*

ME 3860 Thesis and Seminar (Master of Science Degree) (formerly 02.990, 02.991, and 02.998) 8 Q.H.

Any Quarter

Analytical and/or experimental work conducted under the direction of the faculty in fulfillment of the requirements for the degree. First-year students must attend a graduate seminar which will introduce the student to the methods of choosing a research topic, conducting research, and preparing a research report. Successful completion of the seminar is required. *Prereq.: Admission to the Graduate School of Engineering.*

ME 3861 Thesis (Master of Science Degree) 4 Q.H.

Any Quarter

ME 3862 Thesis (Master of Science Degree) 2 Q.H.

Any Quarter

ME 3863 Seminar (Master of Science Degree) (formerly 02.990, 02.998) 0 Q.H.

Any Quarter

First year students must attend a graduate seminar which will introduce the student to the methods of choosing a research topic, conducting research, and preparing a research report. Successful completion of the seminar is required. *Prereq.: Admission to the Graduate School.*

ME 3870 Thesis (Mechanical Engineer Degree) (formerly 02.996) 10 Q.H.

Any Quarter

Analytical and/or experimental work conducted under the auspices of the department. Open to day students only. *Prereq.: Admission to the Mechanical Engineer Degree Program.*

ME 3871 Thesis (Mechanical Engineer Degree) 4 Q.H.

Any Quarter

ME 3872 Thesis (Mechanical Engineer Degree) 2 Q.H.

Any Quarter

ME 3880 Dissertation (PhD Degree) (formerly 02.995) 0 Q.H.

Any Quarter

Theoretical and experimental work conducted under the supervision of the department. Open to day students only. *Prereq.: Admission to the Doctoral Program in Mechanical Engineering.*

Pharmacy and Allied Health Professions

Graduate School of Pharmacy and Allied Health Professions

HRM 3815, HRM 3816 Behavioral Concepts and Organizational Behavior I 6 Q.H.

Major concepts and findings of the behavioral sciences with particular pertinence to business and administration, including systematic ways of understanding behavior. Specific topics include human development and motivation, interpersonal perception and communication, and small groups processes. The second half of the course sequence relates these basic concepts to specific aspects of behavior in formally constituted organizations. Supervisory behavior is examined in the behavioral context, as well as in relations between groups, in efforts to develop ways of achieving collaboration. *Prereq.: Permission from the Graduate School of Pharmacy and Allied Health Professions.*

INT 3101 Biochemistry I 2 Q.H.

Description of the biochemical components of the cell including carbohydrates, lipids, prostaglandins, steroid hormones, amino acids, polypeptides, proteins, purines, pyrimidines, nucleosides, nucleic acids, and vitamins. Consideration of Henderson-Hasselbalch equation, buffers, and importance of pKa. *Prereq.: Two quarters of organic chemistry.*

INT 3102 Biochemistry II 2 Q.H.

Discussion of enzymes, enzyme kinetics, and mechanisms of enzyme reactions. An introduction to the methods used for intermediary metabolism, bioenergetics, biological oxidation-reduction reactions, and the electron transport chain. A consideration is made of carbohydrate metabolism, including the citric acid cycle, the Embden-Meyerhoff pathway, and the pentose phosphate pathway. Use of isotopes in biochemistry and the role of high-energy phosphate compounds are outlined. *Prereq.: INT 3101.*

INT 3103 Biochemistry III 2 Q.H.

Lipid metabolism is presented, including the fatty acid cycle, the biosynthesis of fatty acids, and the biological formation of the prostaglandins, cholesterol, and steroid hormones. The metabolism of the various amino acids is considered, including the urea cycle, one-carbon fragments, transamination reactions, and aromatic hydroxylations. Metabolism of nucleic acids and their building blocks are discussed, as well as the genetic basis of protein synthesis, the genetic code, and the mechanisms of control. *Prereq.: INT 3102.*

INT 3201 Applications of Mass Spectrometry 2 Q.H.

A comprehensive examination of the principles governing the fragmentation and ionization of organic molecules, the interpretation of mass spectra, and discussion of applications of mass spectrometry to the solution of selected problems in the fields of chemistry, biochemistry, and forensic sciences. *Prereq.: 1 year of organic chemistry, basic physics, physical organic chemistry desirable but not essential.*

MLS 3301 Functions of the Human Systems 2 Q.H.

Physiology of the nervous, endocrine, muscular, cardiovascular, respiratory, urogenital and digestive systems. *Prereq.: Chemistry, biology.*

MLS 3302 Pathophysiology I 2 Q.H.

Disease processes as appropriate and inappropriate variants of normal physiological functions. A detailed examination of certain important and illustrative diseases rather than a survey or catalogue of diseases in general. *Prereq.: Mammalian physiology; knowledge of biochemistry is helpful.*

MLS 3303 Pathophysiology II 2 Q.H.

A continuation of MLS 3302 Pathophysiology I. *Prereq.: MLS 3302.*

MLS 3304 Cellular Pathology 3 Q.H.

Topics include cell aging and cell death mechanisms; reactions of cells to injury; the effects of ischemia, oxides of nitrogen, ozone, carbon tetrachloride, mercury, cadmium and polyhalogenated aromatic compounds; storage diseases; immune injury and theories of carcinogenesis. Lectures are based on recent review and current research articles. *Prereq.: Chemistry, biology; biochemistry and cell biology helpful.*

MLS 3306 Biometrics 2 Q.H.

Statistical methods applied to biomedical samples and analysis of biomedical research data. *Prereq.: None.*

MLS 3310 Principles of Medical Endocrinology 2 Q.H.

Endocrine-related clinical abnormalities with emphasis placed on the relationship of clinical laboratory measurement to biochemical dysfunctions of the endocrine system. *Prereq.: Biochemistry.*

MLS 3321 Hematology I—Disorders of the Erythrocytes 2 Q.H.

A detailed examination of the physiology and pathology of red blood cells and hemoglobin. *Prereq.: Some knowledge of basic hematology is essential, and familiarity with general mammalian biochemistry is strongly recommended.*

MLS 3322 Hematology II—Disorders of the Leukocytes 2 Q.H.

The pathophysiology of white cell disorders. Clinical and laboratory correlations of leukemias, myeloproliferative and lymphoproliferative disorders, infections, and inherited leukocyte anomalies. *Prereq.: Undergraduate biochemistry.*

MLS 3323 Hematology III—Coagulation 2 Q.H.

Clinical and laboratory correlations of coagulation disorders. The use of factor analysis in diagnosis of coagulation disorders. *Prereq.: Undergraduate biochemistry, hematology course, or experience.*

MLS 3331 Genetic and Immunologic 1 Q.H.**Aspects of Blood Group Identification**

Lectures dealing with immune response, physical chemistry of immunohematological tests, immunological diseases, tests for detection and identification of antibodies and antigens, principles of human genetics, blood group genetics, and population and family studies. Conducted at the New England Deaconess Hospital Blood Bank Training Center. *Prereq.: MLS 1631 and permission of instructor.*

MLS 3332 Principles and Foundations 2 Q.H.
of the Blood Group Systems

Lectures and experience with the human blood group systems, their antigens and antibodies, genetic inheritance and interactions, frequencies, mutants and alterations by disease states, and blood group testing. Conducted at the New England Deaconess Hospital Blood Bank Training Center. *Prereq.: MLS 3331, MLS 3531 and permission of the instructor.*

MLS 3333 The Design and Problems of 1 Q.H.
Compatibility Testing

Lectures and experience with the design and purpose of compatibility testing; factors complicating compatibility procedure; techniques employed in compatibility testing; leukocyte, platelet, and tissue compatibility; and special crossmatch and transfusion procedures. Conducted at the New England Deaconess Hospital Blood Bank Training Center. *Prereq.: MLS 3331, MLS 3531, MLS 3332, MLS 3532 and permission of the instructor.*

MLS 3334 Principles of Hematology and 3 Q.H.
Coagulation Related to Transfusion

Lectures and laboratory experience dealing with: hemoglobins; iron metabolism; blood formation; blood volume functions of circulating cells; anemias; leukemias and lymphomas; coagulation theories, factors, and disorders. Conducted at the New England Deaconess Hospital Blood Bank Training Center. *Prereq.: Permission of the instructor.*

MLS 3335 Transfusion Therapy 2 Q.H.

Lectures dealing with selection of blood donors, phlebotomy and pheresis procedures, processing requirements, donor reaction, blood components, physical characteristics of stored blood, indications for transfusion, transfusion reaction, therapeutic phlebotomy and pheresis, autologous transfusions, pediatric transfusions, massive blood replacement, extracorporeal perfusion, cardiopulmonary bypass, and dialysis. Conducted at the New England Deaconess Hospital Blood Bank Training Center. *Prereq.: MLS 1631 and permission of instructor.*

MLS 3336 Immunohematology 2 Q.H.
Administration

Lectures and experience dealing with standards for blood banks and transfusion services (federal, state, AABB); requirements for state, FDA, and NIH (BOB) licensing; the American Blood Commission; inspection and accreditation donor procurement; interbank blood exchange; organization of blood bank and transfusion service; medical and legal aspects of

transfusion practice; design of physical facilities; evaluation, selection and maintenance of equipment; evaluation and selection of supplies and reagents; preparation; labeling requirements; quality control systems; proficiency testing programs; record keeping; computer principles, use of computer facilities; operations of donor facilities and blood bank laboratories. Conducted at the New England Deaconess Hospital Blood Bank Training Center. *Prereq.: MLS 1631 and permission of instructor.*

MLS 3338 Immunobiology 2 Q.H.

Topics of current interest in immunobiology, such as organ transplantation, immune tolerance, auto-immune diseases, and the immunology of cancer. *Prereq.: Consent of instructor.*

MLS 3339 Immunopathology 2 Q.H.

The course presents the basic elements for the understanding of clinical immunology and immunopathology. Following a brief review of the components and function of the immune system, the material covered will take into account the current literature relating to the disorders of the complement system, the biologic mechanisms of immunologically induced tissue injury (hypersensitivity reactions), the classification and characterization of immunodeficiency states, (including acquired immunodeficiency syndrome—AIDS), the modes of induction and diagnostic categorization of autoimmune disorders and the immunological features of cancer. *Prereq.: MLS 3338.*

MLS 3341 Advanced Clinical 3 Q.H.
Microbiology I

This course focuses on those aspects of clinical microbiology that are of significance in the understanding of the infectious process, its diagnosis and chemotherapy. It emphasizes the mechanisms of disease production, host defenses, and characteristics of infectious agents that contribute to the diagnosis. Specific topics include infections of the upper respiratory tract, bacterial endocarditis, infectious diarrhea and anaerobic infections, sexually transmitted diseases, nosocomial infections, and basic principles of antimicrobial susceptibility testing.

MLS 3342 Advanced Clinical 3 Q.H.
Microbiology II

Major emphasis of this course is on current topics in infectious diseases. Specific discussions include autoimmune disease syndrome, antibiotic-induced diarrhea, toxic shock syndrome, legionellosis, rapid methods of diagnosis and problems associated with antimicrobial susceptibility testing (tolerance synergism, antagonism, and determination of drug levels in body fluids). *Prereq.: MLS 3341.*

MLS 3345 Epidemiology 2 Q.H.

Basic concepts of epidemiology, causes of disease, factors contributed by agents, the human host, and the environment. Acquisition and evaluation of data. Relationship of person, time, and place. Case studies and problems. *Prereq.: Consent of instructor.*

MLS 3351 Interpretive Clinical Chemistry 2 Q.H.

Discussions of variables affecting results to be considered when interpreting patient chemistry values. This knowledge is pertinent to the laboratorian in determining the validity of performing a particular assay on a specimen collected or stored under certain conditions as well as determining the feasibility of obtained results for particular patient conditions. The course also includes the typical value patterns seen in various pathological conditions to provide background material on frequently encountered pathological variation. *Prereq.: Biochemistry and clinical laboratory experience.*

MLS 3361 Health Science Education I 3 Q.H.

An overview of various aspects of education in the health-related professions to include: design and use of behavioral objectives; evaluation tools (both clinical and didactic); and a survey of various teaching methods. Current journal literature will supplement lecture material. *Prereq.: Health Professions major.*

MLS 3362 Health Science Education II 3 Q.H.

Various types of learning packages or self-instructional aids are examined. With the aid of lecture material and independent assignment, each student will design and produce a 15-minute autotutorial and will present it to the class for critique. Current journal literature will also be used. *Prereq.: MLS 3361.*

MLS 3365 Medical Laboratory Management I 3 Q.H.

This course was developed to provide an opportunity for medical technologists to prepare themselves for managerial responsibilities. Participants are introduced to basic skills and knowledge appropriate to the administration of a medical laboratory rather than specialized functional techniques. The basic objectives of the concentration are: to confront the student with appropriate learning experiences; to increase skills and knowledge in basic disciplines underlying administrative practice; and to develop judgment and skills in problem analysis and decision making in organizations. Major topics to be discussed include supervision; operations; organizations; productivity; human behavior; communications; personnel management. *Prereq.: Medical laboratory experience or consent of instructor.*

MLS 3531 Genetic and Immunologic Aspects of Blood Group Identification Laboratory 1 Q.H.

Laboratory experience dealing with immune response, physical chemistry of immunohematological tests, immunological diseases, tests for detection and identification of antibodies and antigens, principles of human genetics, blood group genetics, and population and family studies. Conducted at the New England Deaconess Hospital Blood Bank Training Center. *Prereq.: MLS 1631 and permission of instructor.*

MLS 3532 Principles and Foundations of the Blood Group Systems Laboratory 2 Q.H.

Laboratory experiences with the human blood systems, their antigens and antibodies, genetic inheritance and interactions, frequencies, mutants and alterations by disease states, and blood group testing. Conducted at the New England Deaconess Hospital Blood Bank Training Center. *Prereq.: MLS 3331, MLS 3531 and permission of the instructor.*

MLS 3533 The Design and Problems of Compatibility Testing Laboratory 2 Q.H.

Laboratory experience with the design and purpose of compatibility testing; factors complicating compatibility procedures; techniques employed in compatibility testing; leukocyte, platelet and tissue compatibility; and special crossmatch and transfusion procedures. Conducted at the New England Deaconess Hospital Blood Bank Training Center. *Prereq.: MLS 3331, MLS 3531, MLS 3332, MLS 3532 and permission of the instructor.*

MLS 3535 Transfusion Therapy Laboratory 2 Q.H.

Laboratory experience with selection of blood donors, phlebotomy and pheresis procedures, processing requirements, donor reaction, blood components, physical characteristics of stored blood, indications for transfusion, transfusion reactions, therapeutic phlebotomy and pheresis, autologous transfusions, cardiopulmonary bypass, and dialysis. Conducted at the New England Deaconess Hospital Blood Bank Training Center. *Prereq.: MLS 1631 and permission of instructor.*

MLS 3536 Immunohematology Administration Laboratory 2 Q.H.

Laboratory experience dealing with standards for blood banks and transfusion services (federal, state, AABB); requirements for state, FDA, and NIH (BOB) licensing; the American Blood Commission; inspection and accreditation donor procurement; interbank blood exchange; organization of blood bank and transfusion service; medical and legal aspects of transfusion practice; design and physical facilities; evaluation, selection, and maintenance of equipment; evaluation and selection of supplies and reagents; preparation; labeling requirements; quality control systems; proficiency testing programs; record keeping; computer principles, use of computer facilities; operations of donor facilities; and blood bank laboratories. Conducted at the New England Deaconess Hospital Blood Bank Training Center. *Prereq.: MLS 1631 and permission of instructor.*

MLS 3538 Immunobiology Laboratory 2 Q.H.

Students are required to undertake individual research projects relating to topics covered in lecture. *Prereq.: None.*

- MLS 3601 Seminar** 1 Q.H.
Topics to be announced quarterly. *Staff.*
- MLS 3801 Graduate Research Report I** 2 Q.H.
Research of a special topic in medical laboratory science, involving individual research, is undertaken and reported under the direction of a faculty member. *Prereq.: Written permission of instructor.*
- MLS 3802 Graduate Research Report II** 2 Q.H.
Students should register twice (4 Q.H.). Continuation of MLS 3801. *Prereq.: MLS 3801.*
- MLS 3821 MLS Thesis** 2 Q.H.
Students should register three times (6 Q.H.). *Prereq.: Written permission of instructor.*
- MSC 3932 Introduction to Computer Applications** 3 Q.H.
A business-oriented introduction to data processing functions and systems. Introduction to the history, terminology, technology, and economics of data management issues in the design, selection, evaluation, and use of computers and computer services. Individual familiarization with elementary computer programming by using either batch or time-shared computer facilities to solve simple business-oriented exercises. When feasible, a visit to a data processing center is conducted. *Prereq.: Permission from the Graduate School of Pharmacy and Allied Health Professions.*
- MTH 3221 Biostatistics** 2 Q.H.
Methods of statistical inference with applications to biology and the medical sciences.
- PA 3101 Clinical Neurology** 4 Q.H.
Clinical application of neuroanatomy and neurophysiology. Students will have the opportunity to develop an understanding of the normal functioning of the nervous system as well as to develop a clinical approach to the assessment management of a variety of nervous system disorders and disease states. *Prereq.: PA 1125, PA 1139.*
- PA 3102 Principles of Electrocardiography** 4 Q.H.
Principles of electrophysiology and its application to electrocardiographic tracing. Students receive instruction in recognizing arrhythmias, rate and axis determination, conduction abnormalities, characteristic changes seen in myocardial infarction, and ischemia, as well as drug and metabolic effect manifested on the electrocardiogram. *Prereq.: PA 1136, PA 1337, PA 1125, PA 1139.*
- PA 3103 Rehabilitation Medicine** 4 Q.H.
Techniques of effective planning and decision making for patients with multiple chronic problems. The purposes, techniques, and potential of rehabilitation medicine are also discussed. *Prereq.: PA 1336, PA 1337, PA 1338, PA 1358.*
- PAH 3201 Drug Literature Evaluation** 2 Q.H.
Principles and practice of drug information, literature retrieval, and evaluation of the pharmacy and medical literature. *Prereq.: Admission to Pharm.D. program.*

- PAH 3211, PAH 3212, and PAH 3213 Pharmacotherapeutics I, II, III** 2 Q.H. each
A three-quarter sequence in advanced contemporary therapeutics of disease. Topics parallel material presented in Principles of Medicine sequence. *Prereq.: Admission to Pharm.D. program.*
- PAH 3221 Psychosocial Aspects of Health Care—Seminar** 1 Q.H.
Psychological and social concerns that determine patient behavior and impact on health care. *Prereq.: Admission to Pharm.D. program.*
- PAH 3231 Pharmacokinetics in Drug Therapy** 3 Q.H.
The application of basic and practical clinical pharmacokinetic techniques to patient care. Topics parallel material presented in Principles of Medicine sequence. *Prereq.: Admission to Pharm.D. program.*
- PAH 3301 Introductory Clerkship I** 1 Q.H.
Initial assignment to clinical site. Student rotates through the various clinical laboratories to obtain working knowledge of the role of the clinical laboratory and the data it generates in the management of disease. Emphasis in microbiology, clinical chemistry and hematology areas. Meets approximately four hours/week. *Prereq.: Admission to Pharm.D. program.*
- PAH 3311, PAH 3312, PAH 3313, PAH 3314 Clerkship I, II, III, IV** 4 Q.H., 5 Q.H., 5 Q.H., 5 Q.H.
A four-quarter sequence of advanced clinical clerkship rotations in patient care at various affiliated clinical sites. Students participate in "rounding" activities with medical and other health professionals and have the opportunity to provide drug information in the therapeutic decision-making process. The emphasis in these rotations is on helping students develop skills and familiarity with the application of drugs in the clinical setting as well as the usual progression of disease. Rotations include internal medicine, ambulatory care, and elective experiences. Involves approximately 40 hrs/week. *Prereq.: Admission to Pharm.D. program.*
- PAH 3321 Patient Assessment** 2 Q.H.
General principles of history taking and physical examination. Emphasis is on organ systems of particular importance to the clinical pharmacist in monitoring drug response. *Prereq.: Admission to Pharm.D. program.*
- PAH 401 Health Policy Analysis and Evaluation** 3 Q.H.
Principles of policy analysis applied to health care issues and institutions. Mechanisms of regulatory and economic incentives and constraints will be examined. Applications of benefit-cost and cost-effectiveness analysis to the evaluation of health programs.
- PAH 402 Health Policy Seminar I** 1 Q.H.
Analysis of recent health policy literature. Students will be expected to evaluate and critique published articles and lead a seminar session. *Prereq.: PAH 401.*

PAH 403 Health Policy Seminar II 1 Q.H.
Continuation of Health Policy Seminar I. *Prereq.: PAH 3402.*

PAH 404 Health Policy Seminar III 1 Q.H.
Continuation of Health Policy Seminar II. *Prereq.: PAH 3403.* -

PAH 501 Health Care Delivery 3 Q.H.
Principal components of the health care delivery system with emphasis on its social, political, and economic evolution and development. Future trends and their implications will be discussed.

PAH 502 Professional Dynamics in Health Care 3 Q.H.

Skills and techniques used in developing leadership attributes and in working effectively with individuals and groups in the health care environment. Emphasis is placed on presenting differing, successful approaches for both leadership and interaction in the ambulatory, institutional, professional, legislative, and regulatory health care setting.

PAH 503 Health Research Methodology 3 Q.H.
Interpretation, analysis, and evaluation of research methods used in the literature of health care. Introduction to experimental designs and hypothesis testing. Projects in developing research methodology for prototype research studies in health care.

PAH 3601, PAH 3602 Seminar I, II 1 Q.H. each
A two-quarter sequence covering topics of relevance to the clinical pharmacy practitioner. Principles of effective communication and teaching are discussed. Students are expected to make oral presentations covering various therapeutic and related subjects as well as the progress of their investigational projects. *Prereq.: Admission to the Pharm.D. program.*

PAH 3801, PAH 3802 2 Q.H. each
Investigational Project I, II

Students have the opportunity to demonstrate their ability to identify a problem within the domain of clinical pharmacy, formulate a hypothesis, develop methods to collect and interpret the data in order to test the hypothesis, and report the investigation in writing using a thesis format. (Note "Investigational Component of Pharm.D. Program.") *Prereq.: Admission to Pharm.D. program.*

PCL 3101 Concepts in Pharmacology 2 Q.H.
In-depth coverage of the fundamental principles of pharmacology. The course covers pharmacodynamics, including dose-effect relationships and drug-receptor interactions. Pharmacokinetic concepts, including absorption, distribution, and elimination will be presented as well as common pathways of drug metabolism. Other topics to be discussed include pharmacogenetics, drug resistance, tolerance, and physical dependence. An overview of experimental and clinical drug evaluation in humans will be presented. The course is intended as a necessary prerequisite for succeeding courses in pharmacology and toxicology. *Prereq.: Admission to a graduate department or approval of the instructor.*

PCL 3121 Experimental Pharmacology 2 Q.H.
Prereq.: PCL 3101 or consent of instructor.

PCL 3131 Receptor Pharmacology 2 Q.H.
Receptors for drug substances and for endogenous ligands are reviewed in a format that combines lecture presentations and discussion. Considerable emphasis is placed on the evaluation of current literature. The course covers: techniques available to study receptors; various models for receptor-ligand interaction; stereochemical aspects of receptor interactions; receptor-mediated coupling mechanisms; evaluation of several specific receptor systems. *Prereq.: MLS 3301, PCL 3101, INT 3101, INT 3102, INT 3103 or permission of the instructor.*

PCL 3141 Pharmacology of Drug Dependence 2 Q.H.

An intensive survey of the major drug classes subject to misuse and addiction. Lectures emphasize general concepts of tolerance and dependence, the general pharmacology of prototypes of abused drugs, patterns and consequences of abuse in humans, and recent research advances. Selected research papers are critically examined to stimulate quantitative pharmacologic thinking. *Prereq.: PCL 3101.*

PCL 3151 Pharmacological Basis of Therapeutics I 3 Q.H.

A detailed survey of the chemical and pharmacological basis of the major classes and the following characteristics of a prototype agent from each class: indication; adverse reactions; contraindications; structure-activity relationship; metabolism; mechanics of action; clinically significant. Reading assignments cover animal models relevant to therapeutic screening and/or testing and the appropriate design of clinical trials. *Prereq.: PCL 3101.*

PCL 3152 Pharmacological Basis of Therapeutics II 3 Q.H.
Continuation of PCL 3151. *Prereq.: PCL 3151.*

PCL 3161 Drug Metabolism 2 Q.H.
Presentation of the current principles and methods for studying the metabolic transformation and physiological disposition of drugs and other chemicals of pharmacological and toxicological interest. The chemistry of Phase I and Phase II reactions from a mechanistic and empirical viewpoint is covered. The role of structure, bonding, molecular configuration, substitution, and related physiochemical factors in the enzymatic reaction is assessed. The effects of enzyme induction and other factors such as species, sex, and age on the extent of metabolism are explored. *Prereq.: PCL 3101 or permission of instructor.*

PCL 3301 Pathology 2 Q.H.
The student is introduced to the study of the nature of disease, emphasizing the general mechanisms and pathogenesis. Of paramount importance is the effect of disease on the human body. The language of disease is stressed. Basic principles of disease processes and more common special diseases are

extensively covered. A research paper may be assigned at the discretion of the instructor. *Prereq.: anatomy and physiology.*

PCL 3601 Pharmacology Seminar 1 Q.H.
Prereq.: PCL 3101.

PCL 3801 Pharmacologic Methods I 3 Q.H.
Students carry out experiments in the laboratory of a pharmacology or toxicology faculty member. The experiments serve to demonstrate the techniques utilized in that lab to study a pharmacologic question. *Prereq.: Ph.D. students only.*

PCL 3802 Pharmacologic Methods II 3 Q.H.
Continuation of PCL 3801. *Prereq.: PCL 3801.*

PCL 3811 Research Report in Pharmacology I 2 Q.H.
A selected research project is undertaken by the student under the direction of a faculty member. *Prereq.: PCL 3101.*

PCL 3812 Research Report in Pharmacology II 2 Q.H.
A continuation of PCL 3811. *Prereq.: PCL 3811.*

PCL 3821 Pharmacology Thesis 2 Q.H.
Students should register three times (6 Q.H.). *Prereq. Written permission from Program Director.*

PCT 3101 Introduction to Biopharmaceutics and Pharmacokinetics 3 Q.H.
A course designed primarily to allow students to remedy deficiencies in biopharmaceutics and pharmacokinetics. Topics include general concepts of one and two compartment models; linear and nonlinear pharmacokinetics; drug kinetics after intravenous, intramuscular, or oral administration; practical methods of compartmental models utilizing plasma and/or urinary data; multiple dosing kinetics; bioavailability and bioequivalence of drug products; and effect of renal impairment on drug kinetics. *Prereq.: Permission of instructor.*

PCT 3111 Clinical Pharmacokinetics 2 Q.H.
Emphasis is placed upon applying various pharmacokinetic techniques to estimating dosage regimens, evaluating drug therapy, consulting on drug selection, and assessing bioavailability and bioequivalence data. *Prereq.: A background in biopharmaceutics or consent of instructor.*

PCT 3112 Pharmacokinetics 3 Q.H.
A class designed to acquaint graduate students with the theoretical compartmental analysis in pharmacokinetics. Topics include derivation and treatment of general equations for linear and nonlinear mammillary models. Use of Laplace transform, transfer functions, general partial fraction theorem, and input-disposition functions in pharmacokinetics. Practical methods used to kinetically analyze the absorption, distribution, and elimination of drugs are emphasized. Computer methods, physiological models, and stochastic compartmental systems are explored. *Prereq.: MTH 1245, MTH 1246, graduate standing and permission of instructor.*

PHP 3101 Hospital Pharmacy Administration I 3 Q.H.

An overview of hospital pharmacy services and an introduction to areas of the hospital that either require or relate to pharmacy services. Inventory, purchasing, and pricing are analyzed both qualitatively and quantitatively. The administrative aspects of materials management, ambulatory care, pharmacy and therapeutics committee, investigational drugs, and pharmacy laws are explored. *Prereq.: HRM 3815, HRM 3816.*

PHP 3102 Hospital Pharmacy Administration II 3 Q.H.

Management of a department's personnel and financial resources. Management skills, development of new departmental program, personnel administration and organization are covered, as well as budget preparation, analysis and control, and hospital reimbursement. *Prereq.: PHP 3101.*

PHP 3121 Health Care Administration I 3 Q.H.

The socioeconomics and statistics of health care, including governmental programs, legislative trends, third-party insurance and welfare programs, and other areas that may affect the management of the modern institutional pharmacy. *Prereq.: Admission to the hospital pharmacy program or consent of instructor.*

PHP 3131 Computer Applications in Hospital Pharmacy 3 Q.H.

An extensive review of past, present, and future applications of data-processing systems to institutional pharmacy. Systems design, evaluation, and proposal development to administrators are discussed with emphasis on the interface between the pharmacy staff, computer systems, and the hospital drug distribution process. *Prereq.: 49.932.*

PHP 3141 Legal Aspects/Federal Legislation in Pharmacy 2 Q.H.

An analysis of the federal and state laws relating to the distribution of drugs in the institution. Included are common-law liabilities such as malpractice and other frequently encountered problems. *Prereq.: Admission to hospital pharmacy program.*

PHP 3161 Human Relations in Health Care 2 Q.H.

A study of personnel psychology, organizational structure, wage and performance incentives, employee evaluations, and policy in relation to accepted personnel concepts and procedures. *Prereq.: Admission to hospital pharmacy program or consent of instructor.*

PHP 3165 Special Topics in Hospital Pharmacy 2 Q.H.

Selected topics of interest to pharmacy or the health community in general.

PHP 3201 Clinical Pharmacy 3 Q.H.

The patient-oriented aspects of the application of therapeutic agents to hospital patients. An in-depth study of the relation of therapeutic regimens to lab-

oratory tests and drug interactions. The role of the hospital pharmacist as an active member of the health-care team dealing directly with inpatients and outpatients. *Prereq.: Admission to hospital pharmacy program or consent of instructor.*

PHP 3211 Contemporary Therapeutics I 3 Q.H.

Recent developments in current therapeutic approaches and their rationale in the treatment of cardiovascular, neurological, gastrointestinal, musculoskeletal, and metabolic diseases of a noninfectious nature. Therapy related to aging and selected genetic diseases. *Prereq.: PHP 3201.*

PHP 3212 Contemporary Therapeutics II 3 Q.H.

Current concepts of infectious diseases and the rationale for the chemotherapeutic treatment of these conditions. Diseases of the blood and blood-forming organs, neoplastic disease, and diseases related to deficiency states. *Prereq.: PHP 3201.*

PHP 3231 Drug Monitoring 3 Q.H.

The process by which drugs are monitored to determine their effectiveness, safety, prevention of iatrogenic factors, drug-drug interactions, and matters affecting patient compliance with a therapeutic regimen. The utilization of this information in improving patient care. *Prereq.: PHP 3201.*

PHP 3241 Sterile Products 3 Q.H.

Theory principles, methods, and techniques in preparing sterile, pyrogen- and particulate-free products. Equipment and laboratory design required for manufacturing different types of sterile products and the practical considerations essential for their production. *Prereq.: Permission of instructor.*

PHP 3601 Seminar on Hospital Pharmacy 2 Q.H.

Seminar on current developments or specific problems in hospital pharmacy that have been studied in-depth by students with guidance from the graduate faculty. The student presentations may be alternated with guest speakers on topics of current interest. Student participation in the discussions is an essential objective of the course. *Prereq.: Admission to hospital pharmacy program.*

PHP 3801 Hospital Pharmacy Thesis 2 Q.H.

Students should register three times (6 Q.H.). *Prereq.: Written permission of instructor.*

PHY 3401 Radiation Physics 2 Q.H.

An introduction to the nucleus and modes of spontaneous radioactive transformation. The isotopic abundance of the elements, naturally occurring radioelements and decay series, the kinetics of decay and the relationship between mass and energy. The nature of the emitted radiation and its interaction with matter. *Prereq.: Undergraduate physics.*

PHY 3402 Radiobiology 2 Q.H.

The biological effects of ionizing radiation. Included are a discussion of elementary target theory, radiation chemistry, effects on macro-molecules, cellular and chromosomal effects, recovery processes, and the acute and long-term effects of radiation with emphasis on humans, as well as a discussion of

environmental sources of radiation and the characteristics of internal and external human exposure. *Prereq.: PHY 3401.*

PMC 3101 Chemistry of CNS

3 Q.H.

Depressants

Presentation and discussion of the chemistry, structure-activity relationships, and mechanism of action of general anesthetics, hypnotics and sedatives, antiepileptics, analgesics, tranquilizers, and muscle relaxants. A consideration of the mechanics of drug design and methods of modification is undertaken. *Prereq.: PMC 3105 or permission of instructor.*

PMC 3102 Chemistry of Autonomic

3 Q.H.

Drugs

A discussion of drugs acting on the central nervous system, with special emphasis on the action mechanism of the chemical mediators of the peripheral nervous system. The role of the agents affecting this system—adrenergic and cholinergic and reversible and irreversible inhibitors of these systems—is discussed in relation to their chemical structure and biological activity. *Prereq.: PMC 3105 or permission of instructor.*

PMC 3103 Chemistry of Anti-infectives 3 Q.H.

A study of various chemotherapeutic agents employed in the treatment of infectious diseases. Included are: the sulfonamides, antibiotics, antivirals; antitubercular, antifungal, and antimalarial agents. Special emphasis is on structure-activity relationships, mechanisms of action, and modern research in each area. *Prereq.: PMC 3105 or permission of instructor.*

PMC 3104 Chemistry of Cancer

3 Q.H.

Chemotherapy

Recent developments in new approaches to both carcinogenesis and to the treatment of cancer are emphasized, including alkylating agents, anti-metabolites, hormones, miscellaneous compounds, and combinations of the above with radiation and immunology. Possible mechanisms of carcinogenesis and chemotherapeutic action explored. *Prereq.: PMC 3105 or permission of instructor.*

PMC 3105 Principles of Medicinal

3 Q.H.

Chemistry

This course presents basic underlying chemical principles which account for the properties of drugs and an understanding of drug action. Among the principles relating biologic activity to molecular structure that will be discussed are stereochemical properties of the molecules, the ionization constants, the aqueous and lipid solubility, the ability of the molecules to provide bond, and the ability of molecules to assume different structural conformations on forming these bonds. *Prereq.: Biochemistry and organic chemistry.*

PMC 3161 Phytochemistry

3 Q.H.

The important classes of chemical compounds produced by plants from the standpoint of their biogenetic origin, detection, isolation, and characterization. Application of these techniques to research

in pharmacy, medicine, economics, botany, taxonomy. Introduction to the literature of plant chemistry. *Prereq.: Two quarters of organic chemistry and two quarters of biology.*

PMC 3171 Heterocyclic Drugs in Medicinal Chemistry 3 Q.H.

The application of the combined principles of medicinal and heterocyclic chemistry to the synthesis of pharmaceutically useful compounds. The emphasis of the material presented will be upon a critical evaluation of the literature methods and rationale. *Prereq.: Advanced Organic Chemistry I or permission of instructor.*

PMC 3301 Clinical Chemistry and Biochemistry Analysis 3 Q.H.

The broad range of analytes, reagents, and techniques in clinical chemistry and biochemistry are presented. Examples of *analytes* are: proteins (e.g., plasma proteins, receptors), DNA (e.g., prenatal diagnosis), hormones, neurotransmitters, drugs, carcinogen-DNA adducts, and viruses; of *reagents* are monoclonal antibodies, enzymes, DNA probes, avidin-biotin, and radioisotopes; and of *techniques* are immunoassays, antibody kinetics and specificity, luminescence assays, blotting assays, chemical modification of biomolecules, and methods for biomolecule purification. *Prereq.: INT 3101 or permission of instructor.*

PMC 3501 Identification and Isolation of Natural Products and Organic Medicinals 4 Q.H.

A laboratory course in the identification of various types of plant constituents that have medicinal/pharmaceutical use, and the isolation and characterization of known and/or unknown chemical compounds from selected plant samples. *Prereq.: At least one year of organic chemistry and some background in plant chemistry, e.g., PMC 1440 or PMC 3161, or by permission of instructor.*

PMC 3511 Advanced Drug Synthesis 4 Q.H.

Application of synthetic and analytical techniques to the formation of new drugs. *Prereq.: Two quarters of organic chemistry with laboratory.*

PMC 3601 Medicinal Chemistry Seminar 2 Q.H.

Reports and discussions involving current journal articles and research in medicinal chemistry. *Prereq.: PMC 3101-PMC 3141.*

PMC 3641 Biomedical Science Colloquium 2 Q.H.

Presentations on current research in biomedical science and related areas. Included will be the theoretical basis of the problem as well as experimental results obtained. *Prereq.: Ph.D. candidate.*

PMC 3642 Biomedical Science Colloquium Continuation 0 Q.H.

Prereq.: PMC 3641

PMC 3651, PMC 3652 Seminar and Report in Clinical Chemistry I, II 2 Q.H. each

Reports and discussions of current journal articles in clinical chemistry. *Prereq.: PMC 3301.*

PMC 3799 Doctoral Dissertation Continuation 0 Q.H.

Continuation of PMC 3811 Doctoral Dissertation which must be taken three times before registering for this course. *Prereq.: PMC 3811.*

PMC 3801 Medicinal Chemistry Thesis 2-6 Q.H.

Prereq.: Written permission of instructor.

PMC 3811 Ph.D. Dissertation 0 Q.H.

Prereq.: Written permission of instructor.

RSC 3101 Nuclear Medicine I: Instrumentation 3 Q.H.

An introduction to nuclear detection techniques by both lecture and laboratory demonstration. Various systems are considered, including scintillation, ionization, gas, and solid-state detectors. Basic principles of spectrometry with an emphasis on sodium iodide detectors will be studied. *Prereq.: PHY 3401.*

RSC 3102 Nuclear Medicine II: Instrumentation 3 Q.H.

A study of the application of nuclear detection techniques in the physical aspects of nuclear medicine. Current clinical instrumentation including gamma cameras and scanners, probes, and whole body counters, as well as future developments such as the solid-state and the multiwire proportional cameras, and positron and tomographic imaging devices. Principles of collimation are studied with each system. The application of computers in nuclear medicine. This course includes both lecture and laboratory demonstration and is a companion course to RSC 3101. *Prereq.: PHY 3401 and RSC 3101.*

RSC 3104 Nuclear Medicine: Radiopharmaceutical Laboratory 2 Q.H.

Demonstrations and discussions of the preparation and quality control of radiopharmaceuticals derived from reactor, accelerator, and generator-produced radionuclides. Assay techniques for radiochemical, radionuclide, and chemical purity. Regulatory implications in the handling and dispensing of radioactive drugs. *Prereq.: RSC 3102.*

RSC 3131 Clinical Aspects of Nuclear Medicine 2 Q.H.

The current practice of diagnostic nuclear medicine in large medical centers and small community hospitals. The effect of pathology in the distribution of radiopharmaceuticals will be considered on an organ and disease basis and illustrated with actual patient findings. The techniques employed in imaging the various organs and body compartments will be presented. Factors influencing the decision to perform a diagnostic nuclear medicine procedure and the choice of the agent to be employed will be discussed. *Prereq.: RSC 3102.*

RSC 3201 Radiopharmaceutical Chemistry 3 Q.H.

This course discusses the application of chemistry to the design and synthesis of radiodiagnostic agents. The properties of the radionuclides and their biological carriers as they relate to their uses in nuclear

medicine will be presented. *Prereq.: PMC 3105 or permission of instructor.*

RSC 3301 Radioisotopes in Biological Systems 2 Q.H.

Methodology of radioactive nuclides and application of these isotopes to biology and medicine, with special emphasis on their use in clinical analysis. *Prereq.: Permission of instructor.*

RSC 3601 Seminar and Research Report in Radiopharmaceutical Science 3 Q.H.

This course provides an opportunity for the students to familiarize themselves with literature sources and the latest developments in radiopharmaceutical science. A written and oral presentation will be required in a particular area as evidence of an ability to organize and evaluate published material. *Prereq.: RSC 3102.*

RSC 3801 Radiopharmacy Internship 2 Q.H.

Designed as a practical on-site introduction to the use of radiopharmaceutics in the clinical environment, this course offers students an opportunity to participate in various functions of a radiopharmacy, including ordering, preparing, dispensing, and dispersing radiodiagnostics; manufacturing non-routine agents; maintaining quality control procedures; and keeping records. This course is considered a laboratory course, and arrangements for enrollment are usually made on an individual basis with the site of the radiopharmacy subject to approval by the instructor. Offered during all quarters, registration takes place during the fall quarter only. *Prereq.: RSC 3104.*

RSC 3811 Radiopharmaceutical Research Report I 2 Q.H.

A selected research project is undertaken by the student under the direction of a faculty member. *Prereq.: Written permission of instructor.*

TOX 3101 Concepts in Toxicology I 3 Q.H.

An overview of toxicology describing the elements of method and approach that identify the science. Special emphasis is placed on the systemic site of action of toxicants. The intent of this part of the course is to help provide answers to two questions: 1) What kinds of injury are produced in specific organs or systems by toxic agents? 2) What are the agents that produce these effects? *Prereq.: PCL 3101.*

TOX 3102 Concepts in Toxicology II 3 Q.H.

Continuation of Concepts in Toxicology I. *Prereq.: TOX 3101.*

TOX 3121 Environmental Toxicology 3 Q.H.

The problems of toxic disturbances and distortions of our biosphere are discussed. When appropriate, the mechanism of action of toxic agents and the basis of their selectivity will be examined. Toxic agents are grouped by chemical or use characteristics such as pesticides, food additives, metals, social poisons, chemical carcinogens, teratogens, and mutagens. This course will attempt to provide perspective for the nontoxicologist to the application of the results of toxicologic investigation and a better understanding of those chemicals which, in ever-increasing amounts, threaten health, comfort, or quality of life. *Prereq.: Admission to a graduate department or approval of the instructor.*

TOX 3501 Toxicology Lab 4 Q.H.

Companion to the undergraduate course TOX 1320 Toxicology Lab. In addition to the lab work for TOX 1320, graduate students are expected to complete special projects assigned by their adviser. *Prereq.: Permission of instructor.*

Physician Assistants

The Physician Assistants is a post-baccalaureate certificate program. Those interested in enrolling must get the permission of the director of the Physician Assistant Program.

MLS 1109 Foundations of Medical Laboratory Science 3 Q.H.

Basic laboratory methods employed in primary care, including urinalysis, gram staining, hematocrit, hemoglobin, sedimentation rate, white-cell count, and differential. Laboratory practice is included. *Prereq.: PA students only.*

PA 1120 Roles, Rules, and Resources for Physician Assistants 2 Q.H.

The role of physician assistants, including the manner in which they interact with other health professionals, as well as the way in which their role is perceived by others. This course is also organized to help students gain an understanding of the law as it relates to physician assistants' actions and to help them develop the ability to make referrals to common community resources.

PA 1125 Human Anatomy 2 Q.H.

The basic structure of the human body, highlighting those features which are of clinical importance. Emphasis is on the gastrointestinal, cardiovascular, respiratory, neurological, and musculoskeletal systems.

PA 1134 Physical Diagnosis 5 Q.H.

Techniques of obtaining and presenting an accurate history; performing a competent and thorough physical examination; and synthesizing the results of the history, physical, and laboratory findings to arrive at an accurate evaluation of the patient. Discussion, demonstrations, and patient workups are used to assist students in building these skills.

PA 1139 Medical Physiology 6 Q.H.

A systematic approach to human physiology, offering in-depth study of gastrointestinal function, respira-

tory mechanics, endocrine function, cardiovascular dynamics, and renal and electrolyte function.

PA 1321 Patient Education and Counseling 2 Q.H.

An opportunity to acquire the knowledge necessary for educating and counseling patients. Course materials include a demonstration of ways in which to evaluate patients' needs and readiness to learn, as well as the use of common teaching techniques for issues such as chronic disease management, ostomies, diabetes, heart disease, nutrition counseling, and sex education. *Prereq.: PA 1335.*

PA 1322 Medical Care and Current Social Problems 2 Q.H.

The principal components of the health care delivery system, with emphasis on services, organization, and funding. Selected social problems are used to demonstrate the operation of the medical care system.

PA 1323 Principles and Concepts of Emergency Medicine 3 Q.H.

An introduction to the principles of life-support techniques. Emphasis is placed on the initial management of acute medical and traumatic conditions in hospital and prehospital situations. Students are instructed in basic cardiopulmonary resuscitation techniques. *Prereq.: Successful completion of Quarter I of the physician assistant program.*

PA 1324 Clinical Nutrition 3 Q.H.

The physiological function of essential nutrients; the need for individual nutrients and their food sources; food fads and food additives; the role of nutrition in heart disease, diabetes, common gastrointestinal disorders, obesity, and hypertension.

PA 1335 Principles of Interviewing 2 Q.H.

Various methods of interviewing patients. Emphasis is placed on establishing a relationship and understanding the effects of cultural background and psychosocial problems on the patient's response to illness, goal setting, personality types, and death and dying.

PA 1336 Pathophysiology and Medicine I 3 Q.H.

A systems approach to the principles of disease processes in people. Topics include physiology, pathophysiology, the natural history of disease, diagnostic procedure, and therapeutic measures. Hematology and cardiology problems are usually covered in this portion of the course.

PA 1337 Pathophysiology and Medicine II 3 Q.H.

Continuation of course from previous quarter. Pulmonary, gastroenterology, immunology, and rheumatology problems are usually covered in this portion of the course. *Prereq.: PA 1336, PA 1125, PA 1139.*

PA 1338 Pathophysiology and Medicine III 3 Q.H.

Continuation of course from previous quarter. Renal, endocrine, oncology, infectious disease, and sexually transmitted disease problems are usually covered in this portion of the course. *Prereq.: PA 1336, PA 1337, PA 1125, PA 1139.*

PA 1340 Introduction to Clinical Rotations 4 Q.H.

Clinical rotations, expectations, and requirements for students about to enter their clinical year. Some review of history taking and physical examination skills is conducted, and students are instructed in various clinical procedures.

PA 1341 Applied Study in Emergency Medicine 4 Q.H.

During this rotation, the student has the opportunity to become familiar with the problems encountered in an emergency room. The student is responsible for taking medical histories and performing physical examinations on acute as well as nonemergent patients and presenting these to the medical preceptor. When appropriate, the necessary diagnostic and therapeutic measures are taken. Through didactic sessions at the clinical site as well as clinical training, the student may also be exposed to the emergency management and treatment of conditions such as trauma, shock, burns, asthma, poisoning, allergic reactions, seizures, and respiratory failure. *Prereq.: Successful completion of first year of Physician Assistant Program.*

PA 1342 Applied Study in Medicine 4 Q.H.

During this in-hospital rotation, the student is given the opportunity to take and record histories and perform physical examinations. Attending medical rounds and conferences, performing diagnostic procedures, presenting case write-ups, recording progress notes, and working under the supervision of a doctor of medicine provide the opportunity to become versed in the assessment and management of a variety of medical problems. Emphasis is placed on the skills of collecting, assessing, and presenting patient data for physician review; ordering appropriate laboratory and diagnostic studies; counseling patients in therapeutic procedures; and helping to coordinate the contributions of other health professionals in the management of the patient. *Prereq.: Successful completion of first year of Physician Assistant Program.*

PA 1343 Applied Study in Pediatrics 4 Q.H.

During the pediatric rotation, the student may develop familiarity with outpatient pediatric problems through training in clinics and private pediatric offices. Emphasis during this training is on caring for the child from birth through adolescence. Students are given the opportunity to take histories and perform pediatric physical examinations. Diagnosis and management of common childhood illnesses and evaluation of the variations of growth and development are also stressed. Students have the opportunity to develop skills with which to counsel parents on immunizations, child visits, parameters of growth and development, common psychosocial problems, nutrition, and accident and poisoning prevention. Students may also have the chance to learn how to administer immunizations and, when possible, to do audio and visual screening. *Prereq.: Successful completion of first year of Physician Assistant Program.*

PA 1344 Applied Study in Psychiatry 4 Q.H.

The student is offered exposure to a wide variety of psychiatric problems. Clinical settings include wards, clinics, and multiservice centers. Students are expected to perform mental status exams and to do cognitive testing. Emphasis is on recognizing various types of psychiatric problems that require referral to a specialist and managing those problems that can be handled by the nonspecialist. Rotations may also assist students in furthering their understanding of effective patient interactions and the psychiatric components of health, disease, and disability. *Prereq.: Successful completion of first year of Physician Assistant Program.*

PA 1345 Applied Study in Obstetrics and Gynecology 4 Q.H.

This rotation provides students the opportunity to become involved with obstetric and gynecological services provided by teaching hospitals in the Boston area. The emphasis in obstetrics is on pre- and post-natal care, monitoring a woman in labor, assisting in deliveries, and developing the skill necessary to deliver a child in an emergency situation. Students have the opportunity to take obstetrical histories and perform obstetrical examinations. While rotating through gynecology, the student is expected to learn how to assess and manage a variety of common gynecological problems and to counsel patients on family planning. *Prereq.: Successful completion of first year of Physician Assistant Program.*

PA 1346 Applied Study in Primary Care 4 Q.H.

Students on primary care rotations are offered exposure to aspects of general medical and family practice with emphasis placed on personalized care of well and sick patients. Patient education, counseling, and integration of community services, as well as medical diagnosis and management, are considered a major part of this rotation. *Prereq.: Successful completion of first year of Physician Assistant Program.*

PA 1347 Principles of Obstetrics and Gynecology 3 Q.H.

The anatomy and physiology of human reproduction; normal conception, pregnancy, and delivery; problems in conception; the management of pre- and post-natal periods; and the care and resuscitation of the newborn. Emphasis is on the causes, signs, and treatment of common gynecological problems, including the significance of early cancer detection. Different methods of contraception, the effectiveness of each method, and the contraindication, if any, are covered. The course also covers the medical indications for abortion and the appropriateness of the various methods of pregnancy termination. *Prereq.: PA 1125, PA 1336, PA 1139.*

PA 1348 Principles of Orthopedics 3 Q.H.

Common orthopedic problems, including those of the hand, knee, shoulder, and back. Special problems of acute trauma and the management of uncomplicated orthopedic cases are examined. Instruction also focuses on the techniques of completing an

adequate patient history and physical examination of the orthopedic patient. *Prereq.: PA 1125, PA 1336, PA 1337, PA 1139.*

PA 1349 Principles of Pediatrics II 3 Q.H.

Continuation of course from previous quarter. *Prereq.: PA 1353.*

PA 1350 Principles of Primary Care Management 3 Q.H.

The approach to and management of the patient in a primary care setting. Specific diseases and medical conditions common to primary care practice will be discussed, including low back pain, anxiety, fatigue and weight loss, chest pain, gastrointestinal problems, upper respiratory infections, obesity, and dermatologic complaints. Attention is given to psychosocial aspects of disease as well as aspects of prevention. Students are expected to have a sound basis in pathophysiology and medicine. *Prereq.: PA 1336, PA 1337, PA 1338.*

PA 3102 Principles of Electrocardiography 4 Q.H.

Principles of electrophysiology and its application to electrocardiographic tracing. Students receive instruction in recognizing arrhythmias, rate and axis determination, conduction abnormalities, characteristic changes seen in myocardial infarction and ischemia, as well as drug and metabolic effect manifested on the electrocardiogram.

PA 3103 Rehabilitation Medicine 4 Q.H.

Techniques of effective planning and decision making for patients with multiple chronic problems. The purposes, techniques, and potential of rehabilitation medicine are also discussed. *Prereq.: PA 1336, PA 1337, PA 1338, PA 1134, PA 1139.*

PA 1353 Principles of Pediatrics I 3 Q.H.

Physiological and psychological fundamentals of child development. Emphasis is on the major common pediatric illnesses, their signs, symptoms, and treatment regimens; various types of medications used in pediatrics, their indication and dosage in relation to specific disorders; and the management of pediatric emergencies such as cardiac arrest, anaphylaxis, convulsions, coma, and high fevers. *Prereq.: PA 1125, PA 1134, PA 1136, PA 1139.*

PA 1354 Principles of Psychiatry 3 Q.H.

An opportunity to understand how to work with patients and families exhibiting psychiatric problems. Topics include psychological growth and development, the effect of social milieu on behavior, the psychological bases of drug and alcohol abuse, and the dynamics of psychosomatic problems.

PA 1355 Principles and Concepts of Surgical Intervention in Disease Processes 3 Q.H.

Major and minor surgical conditions, with emphasis on indications for surgical intervention and pre- and post-operative management in both the ambulatory and inpatient settings. *Prereq.: PA 1336, PA 1337, PA 1125.*

PA 1356 Basic Diagnostic Radiology 2 Q.H.

An introduction to the underlying principles, use, and interpretation of radiographs pertinent to primary care medicine.

PA 1357 Cancer Prevention 3 Q.H.

Principles of primary and secondary prevention of cancer. Included in the course is information on biostatistics, cancer as a public health problem, and cancer epidemiology. *Prereq.: PA 1336, PA 1337, PA 1338, PA 1139.*

PLA 1358 Medical Therapeutics 3 Q.H.

A case-study format that involves students in planning the management of common disease states. Used to help students understand the clinical use of common therapeutic agents. *Prereq.: PA 1336, PA 1337, PA 1338, PA 1139.*

PA 1359 Applied Study in Surgery 4 Q.H.

During this rotation students participate in a variety of surgical patient care responsibilities under the supervision of a surgical resident and/or staff surgeon. The emphasis of the rotation is on general surgery, but the students have an opportunity for varying exposure to other surgical specialties and sub-specialties. Students assist in the initial assessment of the surgical patient, including obtaining an accurate medical history and performing a physical examination. As members of the surgical team, the students are involved in pre-operative management, including patient education and any procedures necessary to prepare the patient for surgery. Students assist the surgeon in the operating room when appropriate and have the opportunity to become familiar with operating room procedures and equipment. Students are also involved in the post-operative evaluation and management of the patient. Students will have the opportunity to attend surgical grand rounds and other surgically oriented educational meetings when available at their rotation sites. *Prereq.: Successful completion of first year of Physician Assistant Program.*

PA 1360 Applied Study in Outpatient Medicine 4 Q.H.

During this rotation the students participate in providing health care to the outpatient adult patient under the supervision of a physician specialist in internal medicine. The students will have the opportunity to become involved in the initial assessment and management of adults with a medical complaint as well as the ongoing assessment and management

of patients with established diagnoses. It is anticipated that the student will be exposed to many of the common problems encountered in medical practice, such as hypertension, diabetes, and heart disease. The emphasis is on the assessment and management of both acute and chronic medical problems. *Prereq.: Successful completion of first year of Physician Assistant Program.*

PA 1361 Applied Study Elective 4 Q.H.

This full time clinical rotation provides the student with an opportunity to obtain additional exposure to an area of clinical medicine in which the student has a special interest. Students may choose additional experience in an area covered by required rotations or select a subspecialty such as dermatology, orthopedics, cardiology, geriatrics, etc. All elective rotations are reviewed and must be approved by the clinical coordinator. *Prereq.: Successful completion of first year of Physician Assistant Program.*

PA 3101 Clinical Neurology 4 Q.H.

The clinical application of neuroanatomy and neurophysiology. Students will have the opportunity to develop an understanding of the normal functioning of the nervous system as well as to develop a clinical approach to the assessment and management of a variety of nervous system disorders and disease states.

PCL 1301 Basic Pharmacology 3 Q.H.

The classification, mechanisms of action, and uses of a broad spectrum of therapeutic agents. Dose response, side effects, and adverse reactions are emphasized. *Prereq.: PA students only.*

PHL 3265 Issues in Medical Ethics 4 Q.H.

Designed to help familiarize students with various philosophical perspectives in medical ethics, including historical, classical, ethical, and contemporary philosophies related to issues such as abortion, truth telling, genetic control, and the allocation of scarce medical resources. Euthanasia and paternalism are among topics discussed during the course.

SOC 3226 The Aging Process 3 Q.H.

Socioeconomic and social-psychological consequences of aging from the perspective of health care providers. A major part of the course focuses directly on the biological changes entailed in aging and the appropriate medical management of geriatric patients. Open to students expected to provide health care services to geriatric patients.

Academic Calendar 1985-86

September 1985

2	Monday	Labor Day. University closed.
3-6	Tuesday-Friday	Final examinations for Graduate Schools.
10-11	Tuesday-Wednesday	Fall 1985 registration—Burlington 1:00-3:00, 5:30-8:00
12	Thursday	Fall commencement.
9-14	Monday-Saturday	Vacation period.
16	Monday	Beginning of 1985-86 academic year.
16-19	Monday-Thursday	Fall 1985 registration—Boston 1:00-8:00
23	Monday	Graduate classes begin.

October 1985

14	Monday	Columbus Day. University closed.
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November 1985

11	Monday	Veterans Day observed. University closed.
26	Tuesday	Winter 1986 registration—Burlington 1:00-3:00, 5:30-8:00
28-December 1	Thursday-Sunday	Thanksgiving Day recess.

December 1985

2-5	Monday-Thursday	Winter 1986 registration—Boston 1:00-3:00, 5:30-8:00
9-13	Monday-Friday	Final examinations for Graduate Schools.
16-January 1	Monday-Wednesday	Christmas vacation.

January 1986

1	Wednesday	New Year's Day. University closed.
2	Thursday	Graduate classes begin.
15	Wednesday	Martin Luther King, Jr.'s birthday. University closed.

February 1986

17	Monday	Presidents' Day. University closed.
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March 1986

4	Tuesday	Spring 1986 registration—Burlington 1:00-3:00, 5:30-8:00
10-13	Monday-Thursday	Spring 1986 registration—Boston 1:00-3:00, 5:30-8:00
24-28	Monday-Friday	Final examinations for Graduate Schools.
31-April 5	Monday-Saturday	Vacation period.

April 1986

7	Monday	Graduate classes begin.
21	Monday	Patriots' Day. University closed.

May 1986

26	Monday	Memorial Day. University closed.
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June 1986

9-10	Monday- Tuesday	Summer 1986 registration—Burlington 1:00-3:00, 5:30-8:00
11-12	Wednesday- Thursday	Summer 1986 registration—Boston 5:30-8:00
16-20	Monday- Friday	Final examinations for Graduate Schools.
22	Sunday	Commencement.
23-28	Monday- Saturday	Vacation period.
30	Monday	Graduate classes begin.

July 1986

4	Thursday	Independence Day. University closed.
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September 1986

1	Monday	Labor Day. University closed.
11	Thursday	Fall commencement
15-27	Monday- Saturday	Vacation period.
29	Monday	Beginning of 1986-87 academic year.

Calendar dates are subject to change. The University community will be notified if such changes are necessary.

